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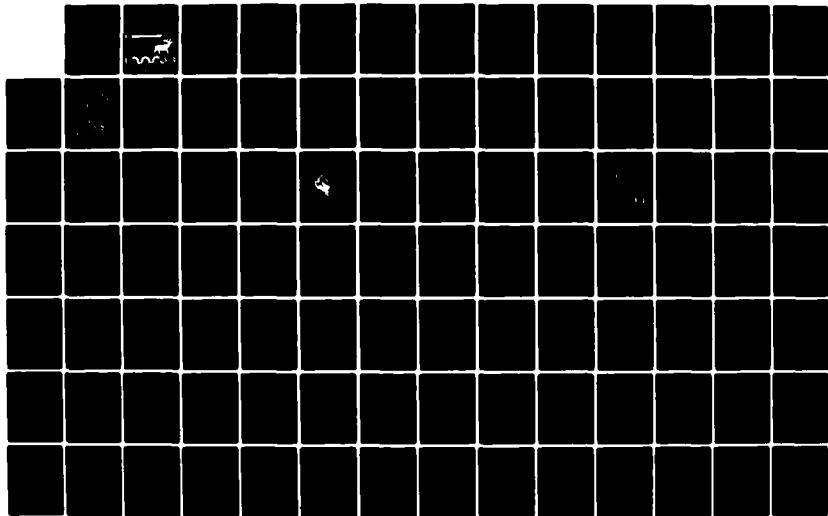
EVALUATION OF PLANNING FOR FISH & WILDLIFE DEER CREEK  
LAKE RESERVOIR OHIO(U) SPORT FISHING INST WASHINGTON DC  
FEB 83 DACW31-79-C-0005

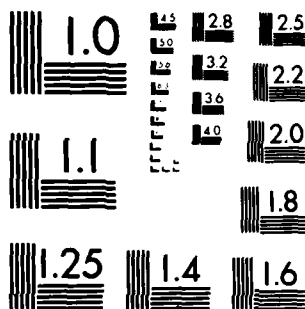
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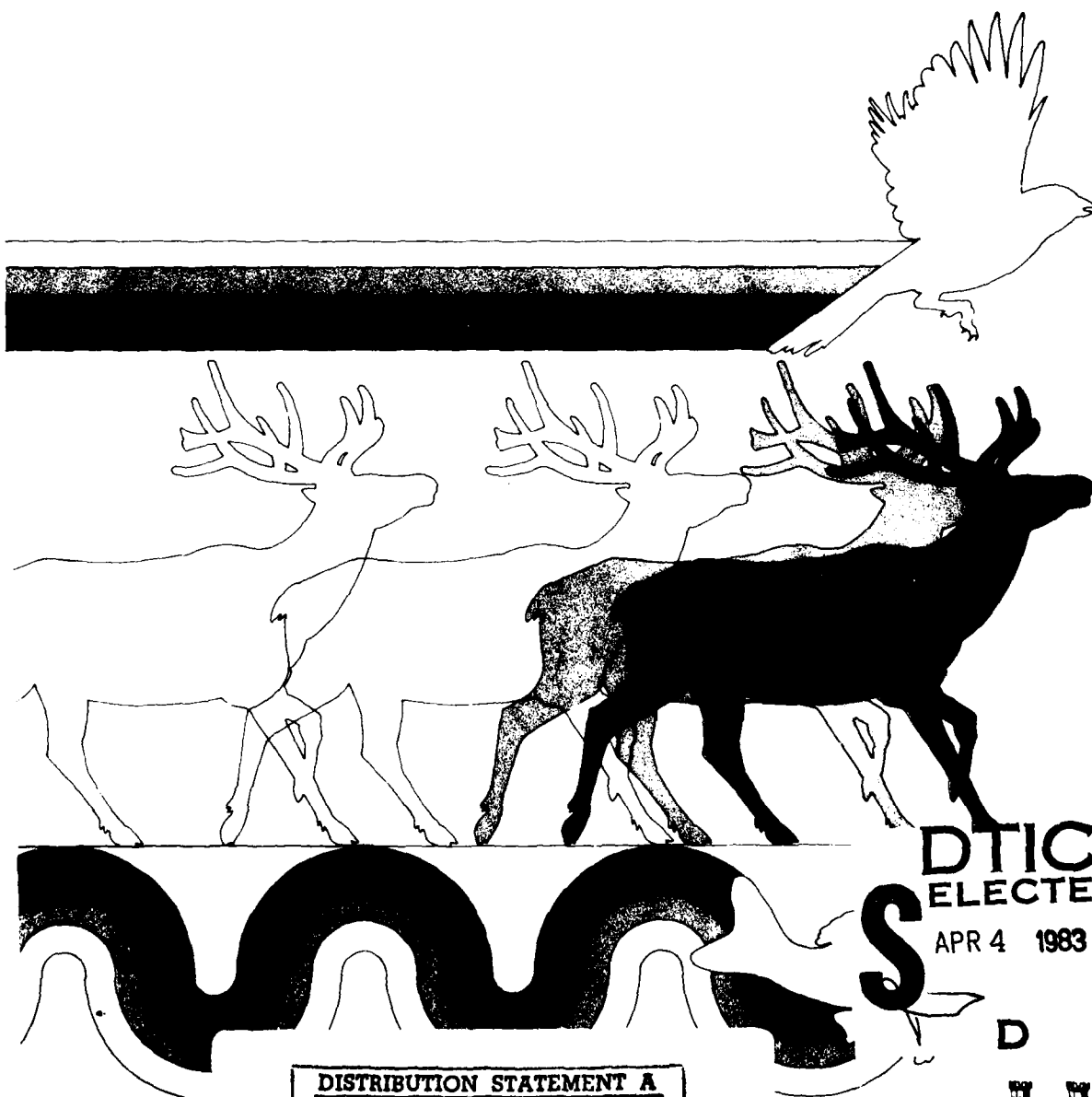
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# Evaluation of Planning for Fish & Wildlife

Deer Creek  
Lake Reservoir, Ohio  
February 1983

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River. Secondary purposes include fish and wildlife enhancement and general recreation.

The Deer Creek Lake project purchase area totals approximately 2,923 ha (7,223 ac) and includes 2,406 ha (5,946 ac) of land circumscribing the 517 ha (1,277 ac) Deer Creek Lake at summer seasonal pool elevation 246.9 m (810 ft) msl. Some 700 ha (1,731 ac) of project land above summer seasonal pool elevation is maintained by the Ohio Department of Natural Resources (ODNR) as a state park (Deer Creek State Park) and 1,565 ha (3,867 ac) for wildlife management purposes (Deer Creek Wildlife Area).

Six separate reports concerning the Deer Creek Lake project were prepared by the FWS over a 16-year period extending from November, 1948 through November, 1964. Each of these FWS reports were prepared in response to changes in project objectives and associate engineering design which occurred over the years.

The initial (November, 1948) FWS report evaluated impacts on fish and wildlife resources anticipated from construction of a single-purpose project designed by the CE solely for temporary flood storage. No attempt was made to document pre-construction or post-project fish and wildlife density levels and/or related man-day use anticipated within the project area.

No record of further fish and wildlife planning by the FWS for the Deer Creek Lake project was found until submission of the preliminary FWS reconnaissance report on July 12, 1961, dealing with CE proposals for construction of eight flood control projects within the Scioto River Basin, including Deer Creek Lake. CE planning at this juncture provided for a permanent minimum pool of 308 ha (760 ac) at the Deer Creek Lake project. This FWS report contained several excellent recommendations for assuring the preservation and development of wildlife resources on lands to be incidentally acquired by the CE within the 5-year flood pool [809 ha (2,000 ac)]. Such lands were to be signed and fenced at project expense and licensed to the ODNR for intensive game management.

Two subsequent reports were submitted by the FWS on November 16, 1961, consisting of a brief letter-report and a more comprehensive substantiating report which provided a thorough evaluation of the anticipated impacts of the proposed project on fish and wildlife resources within the Deer Creek project impact area, including specific estimates of fishing and hunting man-day use.

The FWS submitted several additional planning reports in 1964. The final FWS report dealing with fishery resources was submitted May 14, 1964, and dealt exclusively with planning for reservoir discharge facilities and the recreational fishery in the tailwater. The FWS planning reports dated June 8, 1964 and November 6, 1964, provided an update of FWS wildlife resource recommendations included in the July 13, 1961, report based on receipt of new land acquisition policies which had been adopted by the CE in the interim.

Collectively, the FWS reports submitted to the CE in 1961 and 1964 appeared to adequately address the fish and wildlife resources problems posed by each of the various development regimes advanced by the CE over time. FWS recommendations for mitigation and/or enhancement of fish and wildlife resources were well conceived.

For various reasons, these well-conceived November 1961, FWS recommendations calling for land purchase and wildlife resource development beyond the authorized land acquisition zone were never implemented.

The need for additional project lands for mitigation of upland game resources was reduced considerably by interim changes in land acquisition policies which

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resulted in the purchase of substantially more land [1,619 ha (4,000 ac)] than originally proposed [1,137 ha (2,810 ac)].

Also, although initially approved by the CE, efforts to amend project authorization to include the acquisition and development of the recommended waterfowl management area were unsuccessful--primarily because of opposition by the United States Bureau of the Budget. After due consideration, the FWS decided not to request development of the previously recommended waterfowl management area.

Most of the fishery-resource-related recommendations were later implemented by the CE. The May 14, 1964 FWS report correctly anticipated and made appropriate recommendations to mitigate the substantial fish loss from the lake via discharge sluices which subsequently occurred in post-impoundment years.

In most instances, project planning for the Deer Creek Lake project reflected excellent coordination between the CE, FWS, and the ODNR. However, there was a major discrepancy regarding the ultimate size of the Deer Creek Lake pool as finally constructed [517 ha (1,277ac)] and as described in prior FWS planning documents, which apparently reflected inadequate coordination between the CE and FWS during the final phases of project planning.

→ Post-impoundment assessments of fishing and hunting man-day use were considerably below the levels predicted by the FWS. Documented post-impoundment hunting man-day use, 10,218 man-days, was 61 percent lower than predicted. Hunting effort for upland game species (pheasants, rabbits, and squirrels) was estimated at 8,311 man-days during the 1980-1981 OCWRU survey, or some 66 percent lower than the 24,280 man-days predicted in the final November 6, 1964 FWS report. Hunting effort for waterfowl, estimated at only 345 man-days during the 1980-1981 OCWRU survey, was 83 percent lower than the 2,000 man-days predicted by the FWS.

Contrary to FWS predictions that the project impact area would not afford any post-project hunting opportunity for deer, the OCWRU survey report estimated a total of 1,562 hunting man-days were spent exclusively in pursuit of deer during the 1980-1981 hunting season.

FWS report predictions of post-impoundment angling man-day use proved to be substantially overstated. Post-impoundment creel surveys conducted by the ODNR in 1979 indicated an annual angling effort of only 21,692 man-days [42/ha (17/ac)] in the 517 ha (1,277 ac) lake, which was less than one-eighth of the level of fishing pressure as predicted in the 1961 FWS reports [331 man-days/ha (134/ac)].

Conversely, the 1961 FWS planning report prediction of post-project angling man-day use in the tailwater [5,175 man-days spread over some 12.5 km (7.75 mi)] was several-fold less than the estimate derived from the 1979 creel survey conducted by the ODNR [a total of 31,945 man-days from an abbreviated 0.6 ha (1.4 ac) area located immediately below the dam]. Including both the lake and tailwater, the Deer Creek Lake project impact area supported an estimated total of 53,637 fishing man-days, or approximately 70 percent less than the post-impoundment prediction contained in the FWS planning report.

However, → Estimated total post-impoundment hunting man-day use was twelve times greater and fishing man-day use was eleven times greater than predicted by the FWS without the project.

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STUDY TO EVALUATE THE ADEQUACY AND  
PREDICTIVE VALUE OF FISH AND WILDLIFE  
PLANNING RECOMMENDATIONS AT CORPS  
OF ENGINEERS RESERVOIR PROJECTS

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

THE DEER CREEK LAKE PROJECT

Conducted for Office, Chief of Engineers, U. S. Army

By Sport Fishing Institute, Washington, D.C.

Under Contract No. DACW31-79-C-0005

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## PREFACE

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW31-79-C-0005. The contract requires the compilation and comparison of pre- and post-construction data treating fish and wildlife for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving fish and wildlife planning.

This evaluation of the adequacy and accuracy of fish and wildlife planning at the Deer Creek Lake project in Ohio was aided significantly by the participation and active cooperation of many individuals. U.S. Army Corps of Engineers personnel in the Huntington District Office, including Ed Goodno and Charles Johnson, supplied many useful documents describing both pre-impoundment and post-impoundment conditions. Kenneth Cronnemeyer at the Columbus, Ohio, Office of the U.S. Fish and Wildlife Service provided all available pre-construction planning documents.

Post-impoundment follow-up data were made available from staff of the Ohio



Department of Natural Resources. Ronald Schaefer, Supervisor, Fish Management, District One of the Ohio Department of Natural Resources, furnished post-impoundment fisheries data. Few data were available prior to this study, with regard to post-impoundment wildlife conditions at the Deer Creek Lake project. A sub-contract study to acquire the necessary data was conducted by the Ohio Cooperative Wildlife Research Unit. Dr. Jonathan Bart, Assistant Unit Leader, assisted by Karen M. Cunningham, coordinated the investigation. Additional information concerning project-associated wildlife resources was provided by David Watts and David Graham of the Wildlife Division of the Ohio Department of Natural Resources. Gordon Robertson, Northeast Field Representative with the Wildlife Management Institute, accompanied project personnel on a tour of the Deer Creek Lake project and reviewed the draft manuscript.

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SPORT FISHING INSTITUTE

PROJECT PERSONNEL

Robert Martin (Project Leader)

Norville Prosser (Assistant Project Leader)

Gilbert Radonski (Contractor's Representative)

Naomi Higgins and Nancy Snyder (Project Secretaries)

CONSULTANT'S REVIEW

Professional terrestrial wildlife consultative services were provided by the staff of the Wildlife Management Institute (WMI). Project personnel were accompanied by a WMI staff specialist during field reconnaissance and on-site discussions. The terrestrial wildlife portion of the prepared evaluative manuscript was reviewed and evaluated by WMI.

## INTRODUCTION

### Location

Deer Creek Lake is located on Deer Creek, a tributary of the Scioto River, in Pickaway, Madison, and Fayette Counties, Ohio, approximately 56 km (35 mi) south of metropolitan Columbus and 11 km (7 mi) southeast of Mount Sterling, Ohio (Figure 1). The three-county area in which the project is located had a population of 82,381 in 1980.

The dam is located 34 km (21 mi) above the mouth of Deer Creek and 170 km (1,058 mi) above the mouth of the Scioto River (1).

The 717 km<sup>2</sup> (277 mi<sup>2</sup>) drainage area above the dam is situated within the glaciated till plains section of the central lowlands physiographic province in south-central Ohio. The topography is characterized by relatively low relief with flat-crested hills and broad flood plains (2).

The fertile Deer Creek drainage basin is almost entirely agricultural with corn ranking as the most important crop followed by soybeans, hay, and cereals. Wooded areas within the basin consist of scattered upland woodlots of small size and a narrow fringe of bottomland hardwoods along the watercourses (2).

Annual precipitation averages 102 cm (40 in) and is well distributed throughout the year. The growing season averages approximately 160 days extending from about May 1 through October 10.

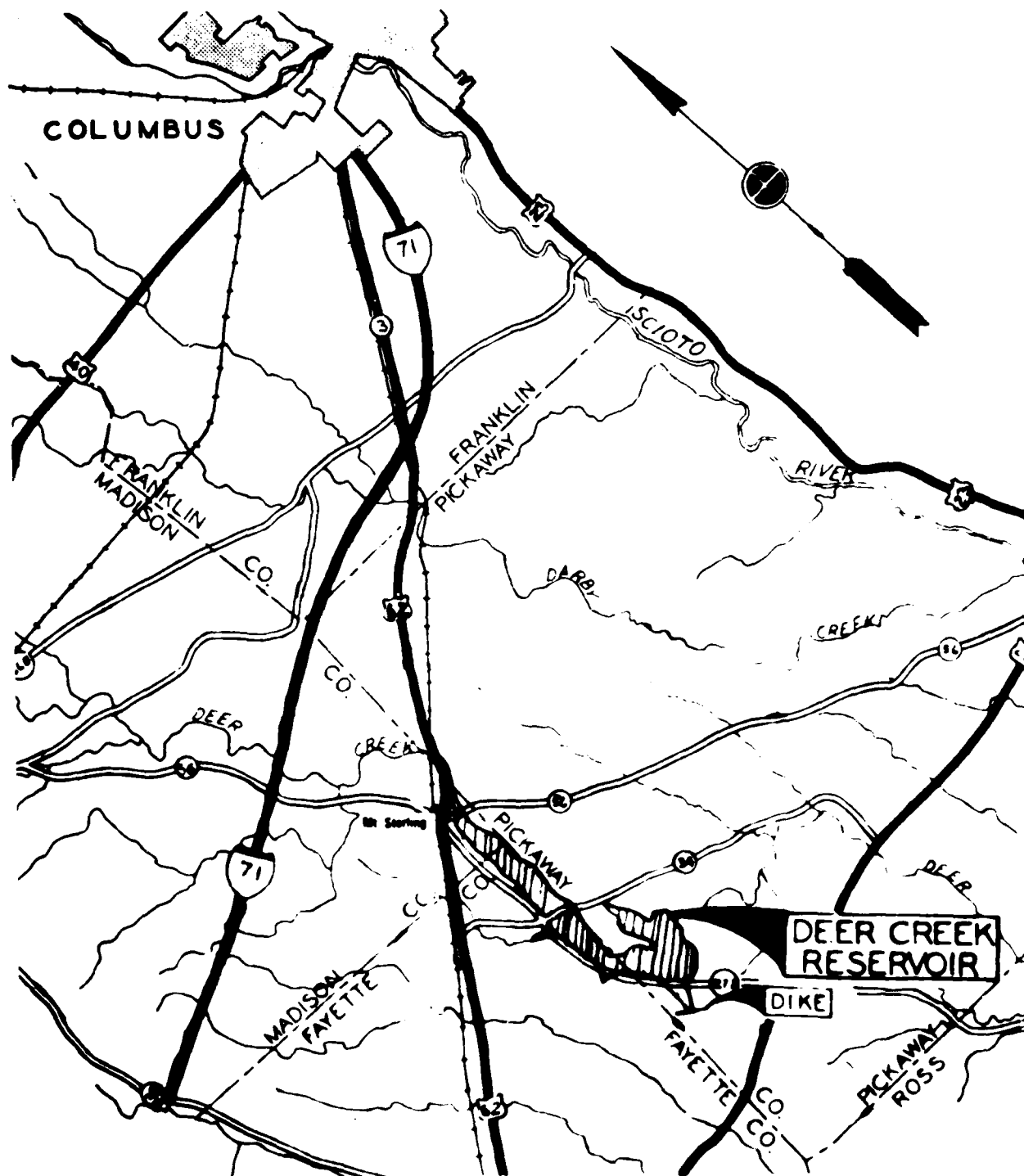


Figure 1. Deer Creek Lake project. Location map.



### Authorization

The Deer Creek project was constructed as a unit of the comprehensive flood control plan for the Ohio River basin and authorized under authority of the Flood Control Act of June, 1938 (Public Law No. 761, 75th Congress, First Session). The primary project purpose is for the control of floods on Deer Creek and the Scioto River. Secondary purposes include fish and wildlife enhancement and general recreation.

### Physical Features

Deer Creek Lake was impounded in the spring of 1968. The dam is a combination earth and concrete structure with a crest length of approximately 1,183 m (3,880 ft) and a maximum height above the stream bed of 28.3 m (93 ft). An earth dike with a crest length of 1,402 m (4,600 ft) and a maximum height of 4.6 m (15 ft) is located approximately 6.1 km (3.8 mi) southwest of the dam.

The Deer Creek Lake project purchase area totals approximately 2,930 ha (7,239 ac) and includes 2,413 ha (5,962 ac) of land circumscribing the 517 ha (1,277 ac) Deer Creek Lake at summer seasonal pool elevation 246.9 m (810 ft) msl. The average depth of the lake at summer seasonal pool elevation averages 5.0 m (16.5 ft) with a maximum depth of 12.2 m (40 ft) and a storage capacity of  $2.59 \times 10^7 \text{ m}^3$  (21,000 ac ft).

Some 771 ha (1,905 ac) of project land above summer seasonal pool elevation is maintained by the Ohio Department of Natural Resources (ODNR) as a state park (Deer Creek State Park) and 1,501 ha (3,709 ac) for wildlife management purposes (Deer Creek Wildlife Area). Some 141 ha (348 ac) has been retained by the U.S. Army Corps of Engineers (CE) for administrative purposes (3).

At the top of design flood pool elevation, 257.3 m (844 ft) msl, the lake would encompass 1,637 ha (4,046 ac) with a total capacity of  $1.264 \times 10^8 \text{ m}^3$  (102,500 ac ft). The surface area of the lake is reduced to 294 ha (727 ac) with a storage capacity of  $7.895 \times 10^6 \text{ m}^3$  (6,400 ac ft) during the winter at minimum pool elevation 242.6 m (765 ft) msl (Table 1).

The outlet works consist of one 1 m (3.0 ft) diameter low flow sluice located approximately 7.3 m (25 ft) below the lake surface at summer seasonal pool, and a series of five sluices [1.5 m (5 ft) x 1.7 m (5.5 ft) each] located at invert elevation 235.5 m (772 ft) msl.

Table 1. -- Deer Creek Lake project. Summary of pertinent physical characteristics

Item	Design data	
<u>Elevations (msl) at dam [m (ft)]</u>		
Top of dam	261.5	(858)
Top of flood control pool	257.3	(844)
Top of recreation pool	246.9	(810)
Minimum pool	242.6	(796)
Stream bed at dam	233.2	(765)
One upper sluice <sup>1/</sup>	239.6	(786)
Five lower sluices <sup>2/</sup>	235.3	(772)
<u>Shoreline length [km (mi)]</u>		
Minimum pool	15.6	(9.7)
Recreation pool	32.2	(20)
<u>Surface area [ha (ac)]</u>		
At top of flood control pool	1,637	(4,046)
At top of recreation pool	517	(1,277)
At minimum pool	294	(727)
<u>Storage capacity [m<sup>3</sup> (ac ft)]</u>		
For winter flood control	$1.186 \times 10^8 \text{ m}^3$	(96,100)
For summer flood control	$1.005 \times 10^8 \text{ m}^3$	(81,500)
At top of recreation pool	$2.59 \times 10^7 \text{ m}^3$	(21,000)
At top of minimum pool	$7.895 \times 10^6 \text{ m}^3$	(6,400)
Total design storage	$1.264 \times 10^8 \text{ m}^3$	(102,500)
<u>Natural stream flow<sup>3/</sup> [m<sup>3</sup>/sec (cfs)]</u>		
Average annual	8.1	(286)
Average minimum monthly flow (Aug.)	0.053	(1.87)
<u>Design minimum release flow [m<sup>3</sup>/sec (cfs)]</u>		
	0.28	(10.0)
<u>Reservoir depth [m (ft)]</u>		
Maximum depth	12.2	(40)
Average depth	5.0	(16.5)
<u>Project land acquisition [ha (ac)]</u>		
Total project area acquired	2,923	(7,223)
Area above flood pool	1,286	(3,177)
Area above recreation pool	2,406	(5,946)
Area above minimum pool	2,629	(6,496)
Area of original stream impounded	17	(42)

<sup>1/</sup>One, 1 m (3.0 ft) diameter low flow sluice.

<sup>2/</sup>Five, 1.5 m (5.0 ft) x 1.7 m (5.5 ft) sluices.

<sup>3/</sup>Based on 27 years of record for the USGS gage located at Williamsport, Ohio.

## WILDLIFE RESULTS AND DISCUSSION

### Wildlife Resources--Pre-impoundment Predictions

The first reference to fish and wildlife resources planning for the Deer Creek Lake project was found in a U.S. Fish and Wildlife Service (FWS) report, dated November 15, 1948, entitled, "A Preliminary Evaluation Report on the Fish and Wildlife Resources in Relation to the Proposed Water Development Plan for the Deer Creek Reservoir Project, Deer Creek, Scioto River Subbasin, Ohio River Basin" (4).

The report was based on preliminary engineering data supplied by the Huntington District, CE, in a December 29, 1947 letter. As proposed originally by the CE, the Deer Creek Reservoir project would be constructed solely as a flood control facility without any provision for maintenance of a permanent pool. At the top of the design flood pool, elevation 253 m (830 ft), the lake would cover an area of 1,085 ha (2,680 ac) with a storage capacity of  $9.252 \times 10^7 \text{ m}^3$  (75,000 ac ft). The authors of the FWS report assumed that all flood water storage would be released as rapidly as possible.

Pre-impoundment wildlife resources within the proposed reservoir site were summarized in the November, 1948 FWS report as follows (op. cit.):

The chief value of the wildlife resources in the proposed reservoir site is derived from certain upland game species--namely, the cottontail, the fox squirrel, and the ring-necked pheasant, and from two fur-animal species--namely, the muskrat and the mink. No big-game animals are present and the waterfowl harvest is insignificant. Hunting and trapping is almost entirely local in character. The pre-project wildlife resources are assigned a tentative value of about \$400 annually.

Temporary flooding of the reservoir basin occasioned by construction of the

project was expected to decrease pre-impoundment wildlife values (\$400) by \$100 or some 25 percent, viz:

The chief loss, if the project is constructed, would be sustained by upland game species. It is estimated that this resource would be reduced by about 20 percent. Aquatic furbearer and waterfowl values would remain essentially the same. Effective habitat for terrestrial furbearers is expected to be reduced by about 25 percent, but this reduction is of little consequence. In this group, only the raccoon has a significant economic value. A tentative value of \$300 is assigned to the post-project wildlife resources.

The FWS prepared three additional reports pertinent to the Deer Creek Reservoir fish and wildlife resource impacts in calendar year 1961 which accommodated revised engineering data supplied by the CE. The first of these reports, submitted by the FWS as a preliminary letter-report dated July 12, 1961, provided a description of with-the-project wildlife resources (5). The total project impact area, as described by the CE, totaled 1,287 ha (3,180 ac), including a 308 ha (760 ac) minimum pool. Lands within the 5-year flood frequency zone totaling 809 ha (2,000 ac) were to be acquired in fee simple and flowage easements were to be secured for an additional 478 ha (1,180 ac) area between the 5-year flood frequency zone and maximum flood pool elevation.

The FWS report assumed that no additional project lands would be acquired specifically for wildlife resource mitigation and/or enhancement. With the project in place, the FWS predicted the project area would support some 4,340 upland game hunter man-days per year valued at \$8,887 over and above the 620 hunter man-days per year valued at \$1,281 as estimated without the project. The increase in post-project hunter man-day use for upland game species predicted by the FWS was predicted on the assumptions that free public access to project lands would be provided, that such lands would be adequately fenced

[approximately 37 km (23 mi) at a project cost of \$18,400], and that the ODNR would intensively manage all project lands incidentally acquired by the CE.

Post-project waterfowl hunter man-day use was expected to increase by 188 days annually with a net increase in value of \$564 over the 140 hunter man-days per year valued at \$420 as estimated without the project in place.

Only negligible changes over without-the-project values were expected in man-day use for other wildlife species with the project in place.

A FWS letter-report concerning water development planning for the entire Scioto River Basin, Ohio, was submitted to the CE November 16, 1961 (6). The FWS letter-report was supported by a separate and more comprehensive substantiating report entitled, "Scioto River Basin, Ohio - A Detailed Report on Fish and Wildlife Resources" (7). These reports addressed the collective impacts on wildlife resources at six reservoir sites, including Deer Creek Lake, proposed for development by the CE.

The location and pertinent physical features associated with the Deer Creek Lake project were described in the FWS letter-report as follows (op. cit.), viz:

Deer Creek Reservoir. This reservoir will be for flood control, fish and wildlife conservation, and general recreation. Dam site is at mile 22.2 on Deer Creek (streambed elevation 770) in Pickaway County. The project site will include portions of Fayette and Madison Counties as well as Pickaway County lands. A 670-acre minimum pool will be held at elevation 790. Full flood pool to elevation 838 + will inundate 3,900 acres of land and water. In-fee purchase will include 1,960 acres in the 5-year flood zone to elevation 819 +. Purchase in fee is also

proposed for 320 acres adjoining the site for general recreational development, plus some 850 acres of land in the buffer strip around the 5-year flood zone to protect public recreational values. Some 2,000 acres of lands in the upper flood zone of the site will be acquired through flowage easement purchases.

According to the November 16, 1961 FWS report, hunting opportunity within the Scioto Basin was limited by posting against trespass and assessment of substantial fees for hunting privileges by private landowners, viz:

Hunting for farm game is dependent in large part upon privately-owned rural lands. Demand for farm game hunting is presently in delicate balance with availability of permission to hunt on private lands throughout the farm game portions of the Basin. Some areas have already been closed to any substantial amount of hunting, while landowners in other sections have effectively reduced pressure through charging substantial user-fees for the privilege to hunt on their holdings. The situation is particularly critical in that large part of the watershed that lies within a 40-mile radius of Columbus. The Ohio Department of Natural Resources makes substantial management expenditures on several public hunting areas in the Basin, in large part to absorb enough hunting demand to keep pressures on private lands within acceptable limits. It is doubtful that privately-owned farm lands of the Basin will support material additional hunter use in the future. Additional public hunting lands will be needed to satisfy the increased demand for this type of hunting.

Intensively managed state public hunting areas were expected to sustain substantially greater levels of hunting pressure for farm game species than afforded by unmanaged privately owned holdings (op. cit.), viz:

The farm game resource is and will be of prime importance since it supports more hunting use, and entails more problems, than any other group. Good to excellent habitat occurs throughout the major part of the Basin - excepting the southern end and eastern edge. Annual rate of hunting pressures on various blocks of private farm lands, currently varies between 50 and 200 man-days per square mile. Intensively managed State public hunting grounds in the farm game area of the Basin support annual hunting pressures of some 3 to 4 man-days per acre (1,920 to 2,560 days per square mile).

Waterfowl hunting opportunity also was limited within the Scioto River Basin, although the basin (particularly the Deer Creek Lake project area) was

considered to possess considerable potential for development of waterfowl habitat (op. cit.), viz:

Waterfowl hunting opportunity is presently quite limited in the Scioto Basin. Some excellent late season shooting is enjoyed by a relatively few hunters who know the location of, and have access to, the stream segments that are used by migrating and wintering mallards and black ducks. Waterfowl resource potentials are excellent, particularly in the southern half of the watershed, since substantial numbers of migrating waterfowl cross the area during the fall hunting season. Only a small portion of these birds currently stop in the Basin due to a paucity of satisfactory resting and feeding habitat. Substantial increases in waterfowl use and hunting opportunity could be obtained by development of acceptable habitat and hunting areas....

Substantial potentials of the Basin for waterfowl benefits would be attained through development and management of a waterfowl area on and adjoining the Clark Run section of the Deer Creek project....Basic requirements would be: purchase of 850 + acres of land adjoining the outer boundary of the site; higher estate acquisition of 125 + acres in the upper flood zone of the reservoir; construction of a 60 + acre subimpoundment within the 5-year flood zone project portion of Clark Run valley; and development and intensive management of the 1,000 + acre unit, in conjunction with basic Deer Creek project lands, by the Division of Wildlife, Ohio Department of Natural Resources, under provision of a General Plan.

Wildlife resource development recommended by the FWS at the Deer Creek Lake project was expected to effectively mitigate predicted hunting losses (primarily for farm game species) at other reservoir project sites proposed for construction by the CE within the Scioto River Basin (op. cit.), viz:

A minimum of 600 acres of lands are needed for intensive management to offset significant hunting losses that will be caused by the Mill Creek and Alum Creek Reservoirs; management of 300 acres is needed as mitigation for losses at each of the projects. The 600 acres would be purchased in fee adjoining Deer Creek project lands, preferably adjacent to waterfowl management unit lands and west of the Clark Run arm. This mitigation unit would be managed under provisions of a General Plan by the Division of Wildlife, Ohio Department of Natural Resources, in conjunction with other General Plan management at Deer Creek. Mitigation at Deer Creek would be adequate and efficient, and would be less costly than purchase and management of lands for



these purposes at the Mill or Alum Creek sites or at some other area in a separate unit.

The cost of purchasing the additional 600 acres of land at the Deer Creek Lake project needed to mitigate predicted loss of hunting opportunity at the other proposed CE projects was estimated at \$210,000. Initial development costs were estimated at \$10,540. The total initial investment cost was estimated at \$220,540.

Development of potential waterfowl resources associated with the Deer Creek Lake project was expected to greatly increase waterfowl hunting opportunity within the Scioto River Basin (op. cit.), viz:

Primarily as the result of the specific 1,000-acre waterfowl management unit proposed at Deer Creek, there would be an annual increase in waterfowl hunting of at least 9,900 days valued at \$33,800. The 9,900 hunter-days is an ultra-conservative figure in this instance, since it includes only consideration of the hunting that would occur on the Deer Creek project lands and waterfowl management unit (9,300 days) plus that hunting to be expected at the other 5 reservoirs without influence of the management unit.

It is expected that as the result of the Deer Creek waterfowl management unit, waterfowl hunting will increase in a substantial way, particularly on reservoirs proposed on Big Darby, Paint and Salt Creeks, and on the existing 2,000-acre pool at Rocky Fork Lake. Also, waterfowl hunting would be expected to increase on various stream segments and private lands beyond the reservoirs and to some extent outside Scioto Basin. It is not possible, however, to make a prediction of the actual total magnitude of such hunting increases. Suffice it to say that the actual total increase in hunting use resulting from the waterfowl unit at Deer Creek may be several times greater than the 9,300 days included in this evaluation. The overall effects of the reservoirs (with the waterfowl management unit) will be of sufficient magnitude to be important in serving those objectives of the Mississippi Waterfowl Flyway Plan concerned with distribution of hunting opportunity.

The next formal FWS report pertinent to wildlife resources planning for the Deer Creek Lake project was a June 8, 1964 Special Report (8).

Although clouded by uncertainties regarding eventual Congressional authorization and/or funding, construction of the 24 ha (60 ac) waterfowl sub-impoundment as originally recommended in the November 16, 1961 FWS report still received high priority in the June 8, 1964 Special Report (op. cit.), viz:

Our November 1961 report recommended the construction of a 60-acre sub-impoundment. This pool would be formed by a dike across Clarks Run Valley 500 feet above the Pickaway County Bridge over Clarks Run. The September 7, 1962 Report of the Acting Chief of Engineers, Department of the Army concurred with this and recommended that the project authorization be modified to provide for this. However, the Bureau of the Budget in a September 24, 1962 letter of comments recommended that this project authorization be deferred pending Department of the Interior review of policies concerning migratory waterfowl development features at Federal water resources projects. As a result, the project authorization was not modified to provide for this sub-impoundment. However, we understand that pending legislation, if enacted, would authorize Federal expenditures at Federal water resource projects for migratory waterfowl development features. In view of this pending legislation the technical aspects of constructing this sub-impoundment should be considered in your pre-construction planning.

A final FWS Special Report on land acquisition and management was submitted to the CE on November 6, 1964 (9). This FWS report, which represented the principal fish and wildlife planning document utilized by the CE for the Deer Creek Lake project, accommodated several important developments affecting project authorization which had occurred since submission of previous FWS reports. As one example, project authorization to enable implementation of the previous FWS report recommendation for construction of the 24 ha (60 ac) sub-impoundment and adjacent 407 ha (1,000 ac) waterfowl unit was not obtained (op. cit.), viz:

Our November 1961 Report recommended the construction of a 60-acre sub-impoundment to be formed by a dike across Clarks Run Valley 500 feet above the Pickaway County Bridge. This Report also recommended the acquisition of a 1,000-acre waterfowl enhancement unit adjacent to the 60-acre sub-impoundment. However, project authorization was not modified to include these features.

An alternate proposal for achieving desired waterfowl hunting opportunity enhancement on the Deer Creek Lake project was recommended in the November 6, 1964 FWS report as follows:

There is a need and demand for more waterfowl habitat and waterfowl hunting throughout central and southern Ohio. Deer Creek Reservoir, as cited in previous reports, would make an excellent state waterfowl management area.

Although project authorization does not include the waterfowl enhancement unit and sub-impoundment as recommended in our November 1961 Report, the need for waterfowl habitat and hunting makes it important to give consideration to waterfowl management at the Deer Creek project.

The most feasible method, in view of the limits imposed by project authorization, for providing additional waterfowl habitat would be to concentrate highway construction borrow pits in an area just north of the permanent pool. State Route 207 and the Cook-Yankeetown Road (County Highway 34) will be relocated as indicated on the attached map. Fill material will be required for these relocations. The selection of borrow material for these highway fills should be coordinated with the Ohio Department of Natural Resources, Division of Wildlife and this Bureau.

The project, with the coordinated plan, would support about 2,000 net annual waterfowl hunter-days use valued at \$7,000.

Interim project lands acquisition policy changes also had a substantial impact on potential wildlife resources at the Deer Creek Lake project. The land acquisition policy prevailing at the time of the 1964 FWS report called for fee purchase of all lands within the entire maximum flood pool area plus a contiguous 91 m (300 ft) wide strip. This revised policy provided for substantially more fee purchase land than would have been available under the policy prevailing at the time of the 1961 FWS reports, which stipulated fee purchase of only the area located within the 5-year flood pool.

Other project design parameters were described as follows (9):

The minimum pool at elevation 796' will cover 730 acres including 3.0 miles of stream. The flood control pool at elevation 844' will inundate 4,050 acres including 11 miles of stream.

Approximately 6,810 acres will be acquired to construct the project. Fee title acquisition will include about 6,530 acres and flowage easement about 280 acres.

The redefined project area was deemed to possess excellent potential for wildlife management (op. cit.), viz:

The flood pool portion of the project is excellent upland game habitat. It contains some of the best pheasant range in Ohio with densities ranging from 80 to 160 pheasants per square mile. Cottontail rabbit populations also are high.

Project lands are fertile and well drained, and farming is intensive. This type of land is very adaptable to intensive farm game management.

The project is within 30 miles of metropolitan Columbus. The combination of high population centers, land capabilities, and high farm-game population densities will assure extremely heavy hunter-use with intensive management.

Non-consumptive wildlife-related usage on the project area, although not quantified, was also expected to be high (op. cit.), viz:

Non-hunting but closely allied and associated use also will be high. These activities will include such things as trap shooting, dog training, nature study, bird watching, and field trials.

Of the total of 2,756 ha (6,810 ac) of project lands to be acquired, the FWS recommended that approximately 1,740 ha (4,300 ac) be intensively managed for wildlife by the ODNR and the remaining project lands [1,016 ha (2,510 ac)] managed for general recreation. With intensive management, the FWS predicted that the lands recommended for management by the ODNR specifically for wildlife would support some 21,500 hunter man-days for upland game annually. These trips were assigned a monetary value of \$32,250. This rate of hunting pressure amounts to approximately 12 hunter man-days per ha (5/ac).

Project lands managed for general recreation were also expected to provide some hunting opportunity for upland game, although at a lesser intensity [2.5 hunter man-days per ha (1/ac)] than for lands managed specifically for wildlife (op. cit.), viz:

The remaining project land (2,510 acres) which would be acquired in fee would be managed primarily for General Recreation. Hunting should be permitted on part of this land. About 25% or 630 acres of this land would probably be unsuitable for hunting due to intensive General Recreation development. The remaining 1,880 acres would support a net increase of about 1,880 annual upland-game, hunter-days use valued at \$2,820.

Net hunter man-day use for upland game on project lands was described as follows (op. cit.):

The minimum pool will inundate 730 acres of upland game habitat and thus eliminate about 100 annual upland-game hunter trips.

Thus with the plan in operation the project would support a net increase of about 23,280 annual upland game hunter trips valued at \$34,920.

Overall, including the 2,000 net increase in annual waterfowl hunting man-days anticipated as a result of utilization and management of highway borrow pits for waterfowl, construction of the Deer Creek Lake project was expected to provide a total net annual increase of approximately 25,280 hunter man-days with a monetary value of \$41,920 (Table 2).

The following formal recommendations were proposed (op. cit.):

In order to implement the wildlife plan and to realize the wildlife potential of the Deer Creek project it is recommended that:

1. The approximately 4,300 acres indicated on the attached map be acquired in fee by the Corps of Engineers and managed intensively for wildlife by the Ohio Department of Natural Resources, Division of Wildlife, under the terms of a General Plan.

Table 2. -- Deer Creek Lake Project. Summary of post-project net gain in upland game and waterfowl hunter man-day use and monetary values as predicted in the November 6, 1964 FWS report

Species and management regime	Project area		Hunting man-days		Value(\$)	
	Ha	Ac	Total	No./ha	Total \$	\$/man-day
Upland game						
ODNR Wildlife Management area	1,740	4,300	21,500	12.4	32,250	\$1.50
General recreation (low density)	761	1,880	1,880	2.5	2,820	1.50
General recreation (intensive) <sup>1/</sup>	255	630	0.0	-	-	-
Total upland game <sup>2/</sup>	2,461	6,080	23,280	-	34,920	1.50
Waterfowl <sup>3/</sup>			2,000	-	7,000	3.50
Total project area	2,756	6,810	25,280	-	41,920	-

<sup>1/</sup>No hunting allowed.

<sup>2/</sup>Total reflects an annual loss of 100 upland game hunter man-days per year valued at \$1.50 each from permanent inundation of the 295 ha (730 ac) minimum pool.

<sup>3/</sup>Waterfowl habitat includes the 295 ha (730 ac) Deer Creek Lake minimum pool plus 12.9 km (8 mi) of Deer Creek located within project boundaries above the minimum pool [elevation 242 m (796 ft)].

2. Adequate access to these lands be provided at project cost.
3. Borrow material sites used for highway fill in the relocation of State Route 207 and the Cook-Yankeetown Road (County 34) be selected after consultation with the Ohio Department of Natural Resources, Division of Wildlife and this Bureau with a view to the utilization of borrow pit ponds for the benefit of waterfowl.

#### Wildlife Resources--Post-impoundment Occurrences

Available post-impoundment information pertinent to appropriate identification of habitat types, wildlife communities, and utilization of Deer Creek project lands and waters for wildlife-related uses was not adequate for satisfactory assessment of project impacts on wildlife resources. It was deemed necessary to fill this information gap in order to facilitate evaluation of the accuracy and adequacy of fish and wildlife-related planning at the Deer Creek project. Consequently, the Ohio Cooperative Wildlife Research Unit (OCWRU) was engaged to conduct field investigations on Deer Creek Lake project lands under terms of Subcontract DACW31-79-C-0005(10) negotiated with the OCWRU by the Sport Fishing Institute. The OCWRU contract investigation included studies specifically designed to elucidate consumptive and non-consumptive wildlife-oriented recreational usage and to quantify wildlife habitat, populations, and harvest.

The results of these investigations, which were presented in a December, 1981 report, were used to document the status of Deer Creek Lake wildlife resources under post-impoundment conditions (10).

#### Cover mapping

The Deer Creek Lake project is the first in the series of individual project

evaluations undertaken by the Sport Fishing Institute (SFI) under Contract No. DACW31-79-C-0005 for which adequate data was available to enable comparison of pre- and post-project habitat conditions by cover mapping.

Post-impoundment cover maps for the ODNR-managed wildlife area had been prepared in 1978 by the ODNR Division of Wildlife using Cannon's (1968) procedure (11). This same procedure was followed by the OCWRU personnel for cover mapping the ODNR park area. These maps were based on aerial photographs taken in May, 1979. Field verification of the major vegetative associations occurring within the park area were made during April and May, 1980. Pre-impoundment habitat maps for both the wildlife area and the park area were prepared and analyzed in the same manner except that field verification was not possible. The aerial photographs used by OCWRU personnel for preparing the pre-impoundment cover maps were taken by the CE in 1962.

The first step in the cover mapping procedure followed by the OCWRU involved subdividing the project impact area into three major areas on the basis of functional use: the Park Area, the Wildlife Area, and the Lake Area. Each major area was subdivided into smaller compartments of 40.5 ha-121.4 ha (100-300 ac), then further divided into tracts according to the following seven habitat cover types: cultivated fields, uncultivated fields, brushlands, woodlands, wetlands, open water, and roads and parking lots. The area of each tract was calculated using a compensating polar planimeter.

#### Land use and wildlife habitat composition

As finally constituted, the Deer Creek Lake project purchase area totaled 2,930 ha (7,239 ac). Deer Creek Lake, impounded in the spring of 1968, comprises 517



ha (1,277 ac) at maximum recreational pool level. The ODNR Division of Wildlife intensively manages some 1,501 ha (3,709 ac) of contiguous terrestrial habitat for wildlife and the ODNR Division of Parks manages approximately 771 ha (1,905 ac) under a lease agreement negotiated with the CE on January 1, 1970 (Figure 2). The CE retained jurisdiction over the remaining 141 ha (348 ac), which includes building sites, dam, and appurtenant structures.

Impoundment of Deer Creek Lake resulted in the permanent loss of approximately 517 ha (1,277 ac) of terrestrial habitat located below the recreational pool elevation 247 m (810 ft). The actual area within the recreational pool during the period that cover maps were prepared by the OCWRU was estimated at 499 ha (1,233 ac), or some 17 percent of the total project impact area of 2,930 ha (7,239 ac).

Dramatic changes in land use practices on the remaining project land which occurred after project construction resulted in significant change in terrestrial habitat composition from pre-impoundment conditions (Table 3). Prior to impoundment, the project impact area was intensively farmed by private landowners. Cultivated fields (primarily row crops) made up 69 percent and uncultivated fields amounted to an additional 4.5 percent of the total project impact area. The remaining project area consisted of woodlands (14 percent), brushlands (9 percent), streams and ponds (2.5 percent) and roads (0.8 percent).

Purchase of project lands by the CE and subsequent lease to the ODNR resulted in material changes in land use patterns. By 1980, some 12 years after project construction, the area devoted exclusively to crops had decreased by 82 percent

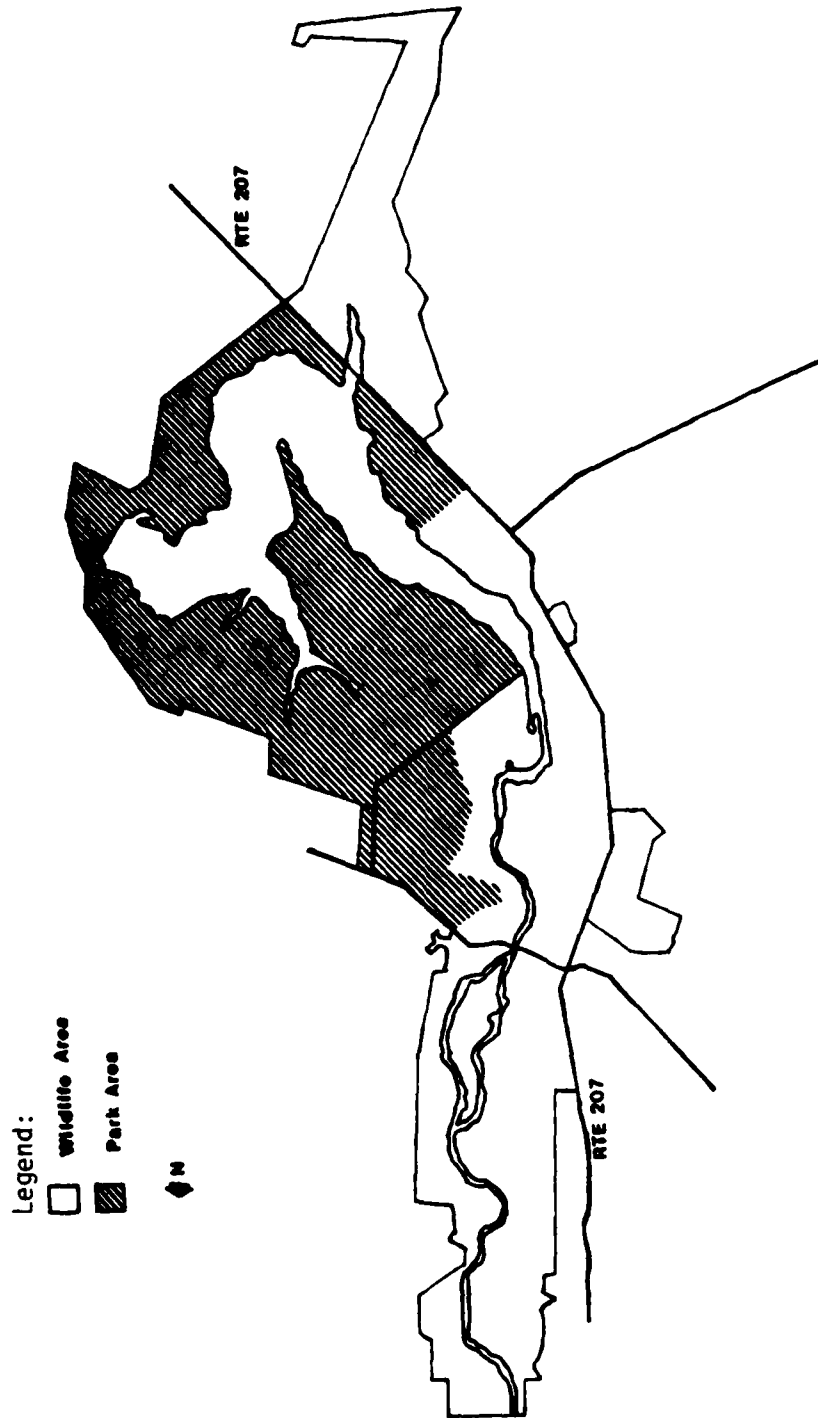


Figure 2. Deer Creek Lake project. Distribution of lands managed by the ODNR Division of Parks and Recreation and the ODNR Division of Wildlife.

Table 3. -- Deer Creek Lake project. Summary comparison of changes in habitat composition within the project impact area as indicated by analysis of pre-project (1962) and post-project cover maps (1980) prepared by the OCMRU

	Cropland		Uncultivated open land		Brushland		Woodland		Roads, etc.		Water <sup>1/</sup>		Total area	
	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac
<b>Parkland</b>														
Pre-project (area)	670	1,656	71	176	68	169	96	238	12	30	11	28	928	2,297
% composition	72	0.0	8		8		10		1		1		100	
Post-project (area)	0.0	0.0	466	1,152	152	376	111	275	192	474 <sup>3/</sup>	7	17	928	2,297 <sup>3/</sup>
% composition	0.0		50		16		12		21		1		100	
Net (post-project area)	-670	-1,656	+395	+976	+84	+207	+15	+37	+180	+444	-4	-11	0.0	0.0
% change	-100		+555		+122		+16		+444 <sup>3/</sup>		-3		0.0	0.0
<b>Wildlife lands<sup>2/</sup></b>														
Pre-project (area)	1,053	2,603	51	125	163	404	177	438	10	24	45	111	1,501	3,709
% composition	70		3		11		12		0.7		3		99.7	
Post-project (area)	368	909	695	1,717	155	384	187	461	41	101	49	122	1,501	3,709
% composition	25		46		10		12		3		3		100	
Net (post-project area)	-685	-1,694	+644	+1,592	-8	20	+10	23	+31	77	+4	11	0.0	0.0
% change	-65		+1,274		-5		+5		+321		+10		0.0	0.0
<b>Original lake site lands<sup>4/</sup></b>														
Pre-project (area)	312	771	10	24	19	47	141	349	0.0	0.0	17	42	499	1,233
% composition	63		2		4		28		0.0		3		100	
Net post-project <sup>4/</sup>	-	-	-	-	-	-	-	-	-	-	-	-	-499	-1,233
% change <sup>4/</sup>	-		-		-		-		-		-		-100	
<b>Total project area</b>														
Pre-project (area)	2,035	5,029	132	326	251	620	415	1,025	22	54	73	181	2,930	7,239
% composition	69		4.5		9		14		0.8		2.5		99.8	
Post-project (area)	368	909	1,161	2,869	308	760	298	736	233	575	56	139	2,429	6,006
% composition	15		48		13		12		10		2		100	
Net (post-project area)	-1,667	-4,120	+1,029	+2,543	+57	+140	-117	+289	+211	+521	-17	+42	-499	-1,233
% change	-82		+780		+23		-28		+965		-23		-17	

<sup>1/</sup>Includes streams primarily, plus small ponds. [Excludes Deer Creek Lake.]

<sup>2/</sup>Total wildlife lands includes additional 1.8 ha (4.4 ac) pre-impoundment, and 5.3 ha (13 ac) post-impoundment of lands classified as "wetlands."

<sup>3/</sup>Includes 146 ha (360 ac) golf course (post-impoundment).

<sup>4/</sup>Terrestrial habitat eliminated in post-impoundment years due to impoundment.

overall and was replaced by a mixture of uncultivated fields, brushlands, and woodlands. All cultivated fields within the designated wildlife area declined by some 65 percent. The 368 ha (909 ac) of cultivated fields remaining in the wildlife area were managed by the ODNR on a sharecrop basis designed to maximize wildlife benefits.

The post-impoundment decline in agricultural lands was reflected by a commensurate increase in uncultivated fields, which increased almost eight-fold after project construction [from 132 ha (326 ac) in pre-project years to 1,029 ha (2,543 ac) by 1980]. Brushlands, which amounted to only 9 percent of the total pre-impoundment project area, made up some 23 percent of the total project area by 1980. The area constituted by roads and other essentially open areas increased from less than 1 percent of pre-project lands to some 23 percent in post-impoundment years [attributable primarily to the development of a 146 ha (360 ac) golf course]. Woodland areas, however, decreased some 28 percent [from 415 ha (1,025 ac) in pre-impoundment years to 298 ha (736 ac)] after impoundment. The reduction occurred primarily as a result of flooding within the lake basin. A modest post-project increase in woodland habitat was achieved in both parklands (16 percent) and the ODNR-managed wildlife area (5 percent).

With the exception of the reduction of woodland habitat, the changes in relative habitat composition which occurred after project construction significantly increased habitat diversity and were considered beneficial for most wildlife components.

Additional post-impoundment wildlife habitat enhancement was provided by the

decrease noted in the size of individual habitat tracts and concurrent increase in the number of discrete habitat areas, which improved habitat interspersion and provided greater "edge" effect (Table 4, Figure 3). The habitat changes occurred as a result of largely fortuitous changes in land use practices on parklands and purposeful habitat manipulation of wildlife lands by ODNR wildlife management personnel.

#### Wildlife communities

For the most part, OCWRU estimates of post-impoundment wildlife community abundance were predicated on observed changes in the amount and quality of post-impoundment habitat available to game species. Estimates of population density (number of animals per unit area) for individual species were based on general statewide (Ohio) averages provided by ODNR wildlife specialists. No specific on-site wildlife inventories were conducted by the OCWRU.

According to OCWRU estimates, the status of the ring-neck pheasant population was improved substantially following project construction, primarily as a result of habitat improvement (10), viz:

The Deer Creek project has clearly had a beneficial impact on pheasant habitat and populations. The amount of optimal habitat has increased nearly 50 percent to about 1,000 acres since 1960...

The OCWRU estimated that the total pheasant population within the Deer Creek Lake project area increased from a pre-impoundment population of 21 birds to 30 birds by 1980 (Table 5). These OCWRU estimates of pheasant density were derived as follows (op. cit.), viz:

Pheasant. ODNR specialists report that in Ohio pheasant population levels are highest in dense shrubby areas near idle fields, primarily of the forbgrass type. They estimate that fall populations in such areas reach 3 birds (1.5 cocks) per 100 acres

Table 4. -- Deer Creek Lake project. Pre-and post-project comparison of the number and size of individual fields and/or tracts as designated by OCMRU cover mapping for cultivated fields, uncultivated fields and brushland habitat

	Cultivated fields			Uncultivated fields			Brushland			Total		
	No.	Ave. size Ha	Ac	No.	Ave. size Ha	Ac	No.	Ave. size Ha	Ac	No.	Ave. size Ha	Ac
<u>Pre-impoundment</u>												
Lake site	27	11.5	28.5	8	1.2		12	1.6	3.9	47	7.2	17.9
Wildlife area	56	18.8	46.5	22	2.3	5.7	69	2.4	5.9	147	8.7	21.4
Parkland	72	9.3	23.0	24	3.0	7.3	29	2.4	5.8	125	6.5	16.0
Total	155	13.1	32.4	54	2.4	6.0	110	2.3	5.6	319	7.6	18.8
<u>Post-impoundment*</u>												
Wildlife area	241	4.4	10.8	282	2.5	6.1	65	2.4	5.9	588	3.8	9.5
Parkland	0.0	0.0	0.0	95	4.9	12.1	65	2.4	5.8	160	3.2	8.0
Total	241	4.4	10.8	377	3.1	7.6	130	2.4	5.8	748	3.4	8.3
<u>Percent change</u>												
(Post-impoundment)*												
Wildlife area	+330	-76		+1182	+7		-6	0.0		+300	-56	
Parkland	-100	-		+296	+66		+124	0.0		+28	-50	
Total	+55	-67		+598	+27		+18	0.0		+134	-55	

\*All lake site tracts eliminated by impoundment.

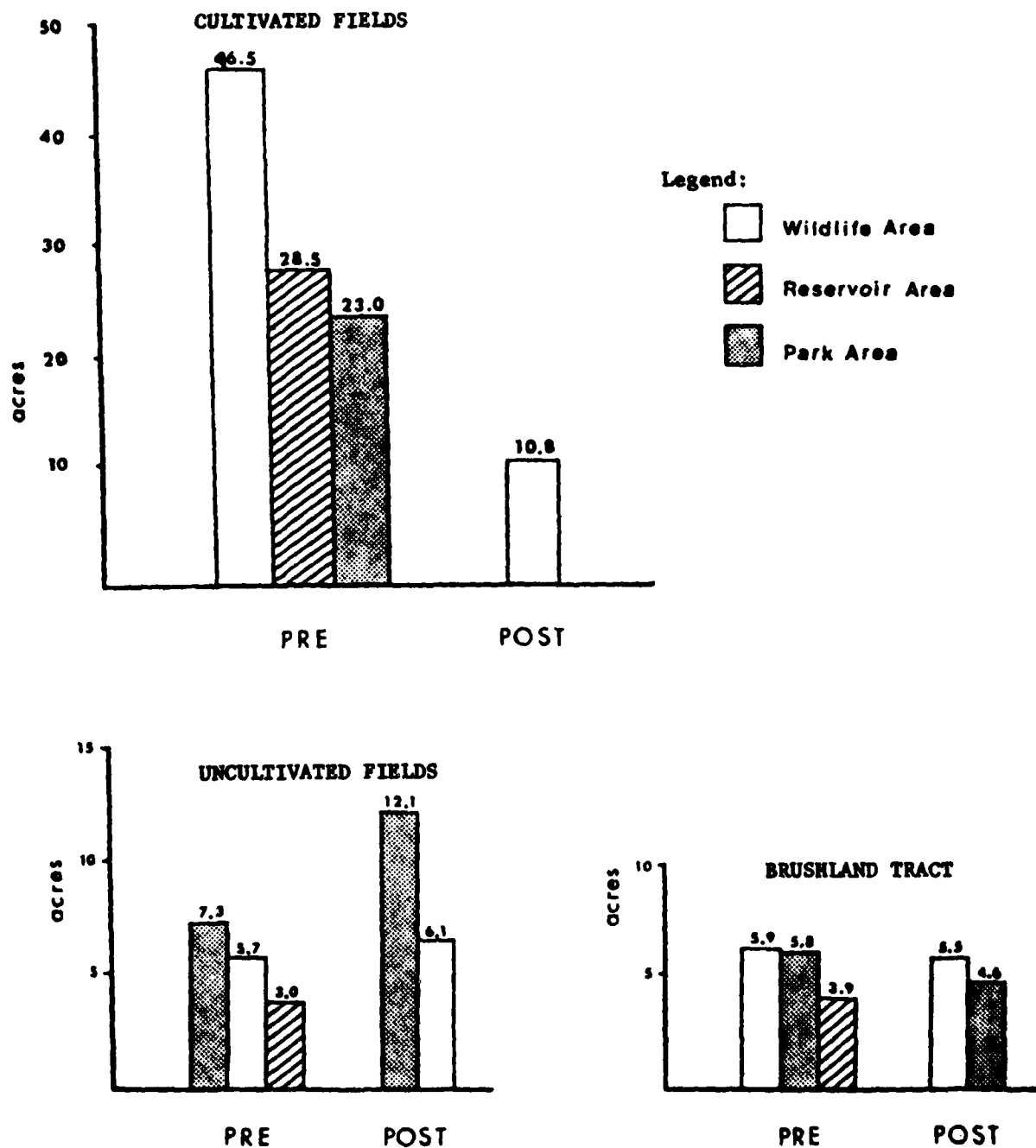


Figure 3. Deer Creek Lake project. Pre- and post-project comparison of the average size (acres) of individual fields and/or tracts occurring within the project impact area.

Table 5. --- Deer Creek Lake project. Abundance of primary game species before and after project construction as estimated by OCMRU personnel

	Pheasant <sup>1/</sup>			Cottontail rabbit			Deer			Squirrel		
	1960	1980		1960	1980		1960	1980		1960	1980	
	Ha	Ac		Ha	Ac		Ha	Ac		Ha	Ac	
Amount of habitat [ha (ac)] <sup>2/</sup>	313	700		447	1,000		175	433		194	550	
Percent change (post-project)			+43			+27			-25			-37
Estimated potential fall population density no/ha (ac)	0.07	0.03		0.07	0.03		5.0	2.0		5.0	2.0	
Estimated total population	21			30			866			1,100		
Percent change (post-project)			+43			+27			+72			-37

1/ Wild pheasant population on the total project area was estimated at approximately 1,000 birds by OCMRU resident area manager. This amounts to a density of approximately 0.29 pheasants/ha (0.18/ac) over the combined park and wildlife areas.

2/ Optimum habitat for pheasant, rabbits, and squirrels; fair habitat for deer in 1960, optimum habitat for deer in 1980.



and that 50 percent of the cock population can be harvested on a sustained basis (R. Boyd, pers. comm.).

However, discussion of these findings regarding post-impoundment pheasant density with the resident manager of the Deer Creek Wildlife Area indicated that pheasant density was substantially underestimated in the OCWRU report (Dave Graham, Deer Creek Wildlife Area Manager, ODNR, pers. comm., 1982). The ODNR Wildlife Area manager estimated that the entire Deer Creek Lake project impact area (including state park areas) currently supported a fall density of some 1,000 wild pheasants. ODNR personnel did not contest estimates of the density of other indigenous game species as presented in the OCWRU report. OCWRU estimates of the abundance of cottontail rabbits as listed in Table 5 (866 in pre-impoundment years and 1,100 in post-impoundment years) were derived as follows (op. cit.), viz:

Cottontails. Cottontails require food and cover in close proximity. At Deer Creek, good cottontail habitat consists of brushland and old fields and some early successional hardwoods. Portions of adjoining fields or lightly stocked woodlands with a dense ground cover also constitute good habitat. In such areas, fall populations of cottontails reach 200 per 100 acres, and 30 percent of the population can be harvested on a sustained basis (J. Henry, pers. comm.).

The 27 percent increase in abundance registered in post-impoundment years was attributed to habitat improvement (op. cit.), viz:

As with pheasants, the Deer Creek project has had a beneficial effect on cottontail populations. Good habitat has increased 27 percent since impoundment as agricultural fields have been allowed to succeed and as patch size has decreased. Periodic construction of brushpiles and mowing of grass strips also account for the increase in good habitat despite the loss of 1,200 acres to the reservoir.

The cottontail population has declined somewhat during the past few years due in large part to severe winters in 1976 and 1977 and perhaps to a tularemia epidemic which is suspected to have occurred in 1979 (D. Graham, pers. comm.).

White-tailed deer were estimated to have increased by 72 percent in post-project years (from a total of 22 to 38 deer) in spite of a loss of some 517 ha (1,277 ac) of habitat as a result of impoundment of Deer Creek Lake. The increase noted in deer density was attributed to greatly improved habitat, particularly better interspersed of desirable habitat types (op. cit.), viz:

White-tailed deer. To reach maximum densities in Ohio, white-tailed deer require a mixture of brushland, woodland, and cropland in roughly equal proportions. Good interspersed of cover types is also necessary. On public hunting lands having this mixture, deer densities typically reach .7 individuals per 100 acres. In contrast, deer densities on private land rarely exceed .3 individuals per 100 acres. The difference is partly due to poorer habitat but is also caused by the necessity of keeping deer damage to crops from exceeding tolerable levels.

Approximately 20 percent of the resident bucks (10 percent of the population) are harvestable each year on both private and public lands (R. Stoll, pers. comm.).

Three-quarters of Deer Creek is considered to be good deer habitat. The only unsuitable parts are the reservoir and a few heavily developed areas. All of the area would be fair habitat if it had stayed in private ownership. The result of this smaller, but more productive, habitat is that deer densities supportable exclusively by Deer Creek are estimated to be nearly twice the level they would have been without the project.

The only game species which declined in abundance after project construction was the fox squirrel (gray squirrels are not indigenous to the project area). Fox squirrel experienced an estimated 37 percent decline with the project in place (from a total of 1,760 to 1,103), which the OCWRU attributed to a commensurate 37 percent loss of post-project habitat (op. cit.), viz:

Fox squirrel. Mature hardwoods with good mast producing trees and densities, especially if cropland is nearby to provide alternate food supplies, constitute optimal squirrel habitat at Deer Creek. Like cottontails, they reach fall densities of 200 per 100 acres in prime habitat; 20 percent of the population can be harvested annually (R. Donohoe, pers. comm.).

This is the only species studied which the project affected adversely. Optimal habitat declined 37 percent due to flooding of woodland in the reservoir area. Since squirrels are not given

high priority in the management plan, no significant amount of new woodland has been created since impoundment.

#### Public use surveys (hunting)

Post-impoundment hunting man-day use and game harvest estimates were developed by the OCWRU from an intensive hunter survey conducted from the opening of the hunting season in September, 1980 and continuing through January, 1981. Interviews were conducted with hunters leaving the project area during randomly scheduled 15-minute interview periods at each of the 16 public access facilities used during the hunting season. Data collected during exceptionally high hunter participation on the opening day of the cottontail rabbit season (November 1, 1980) and the first day of the ring-necked pheasant season (November 15, 1980) were treated separately from data collected during the remainder of the survey period. The survey included all access points available to hunters, including parking lots located on both the ODNR-managed wildlife area and sections of the state park open for public hunting.

The statistical parameters pertinent to the survey are summarized in Tables 6 and 7. Additional insight to survey methodology and problems encountered with statistical interpretation of the survey data was presented in the OCWRU report as follows (10):

A sampling problem. When our interviewer came to an empty parking lot, she often passed directly on to the next lot, assuming that no hunter could arrive, go for a hunt, and return again, all within 15 minutes. While this is undoubtedly true, the practice of collecting data on empty and full lots at different speeds causes considerable analytic difficulty. It makes the sample size a random variable, correlated with the value we are trying to estimate. At slow times a larger sample size is collected than at busy times, thus producing an underestimate. Furthermore, if we neglect travel time between lots (about 2 minutes in our study), it can be shown that the result of waiting at one lot (perhaps preceded by passing several empty

Table 6. -- Deer Creek Lake project. Summary of pertinent statistical data parameters utilized by OCMRU personnel for estimating hunting pressure and game harvest from project lands during the 1980-81 hunting season. [The sampling schedule involved hunter interviews conducted during randomly selected fifteen minute intervals from 16 hunter access areas.]

Species	Interview schedule		No. 15 minute intervals in period		Estimated number hunter man-days		No./interval		Harvest	
	Dates	Hours	Total no.	No. sampled	No./interval	Total no.	(Rabbits)	(Pheasants)	(Rabbits)	(Pheasants)
Rabbits	Nov. 1/80	10 AM-5 PM	476	33	0.80	418	0.090	-	43	-
Subtotal (Rabbits)	Nov. 2-14/80	10 AM-5 PM	4,760	56	0.23	1,104	0.036	-	171	-
Rabbits and pheasants	Nov. 1-14/80	10 AM-5 PM	5,236	89	0.29	1,522	0.41	-	214	-
Subtotal Total	Nov. 15/80	9 AM-3 PM	408	31	2.90	1,184	0.097	0.452	39	184
	Nov. 16-30/80	12-3 PM	2,652	43	1.14	3,023	0.070	0.116	186	308
	Dec./80-Jan./81	10 AM-2 PM; 3 PM-5 PM	3,536	18	0.33	1,167	0.0	0.0	0.0	0.0
	Nov. 15/80-Jan./81	10 AM-3 PM	12,920	320	0.05	659	0.0	0.0	0.0	0.0
Squirrels	Sept./80	8-12 AM	4,576	180	0.078	357	0.17	-	78	-
	Oct./80	5-6 PM	120	15	0.467	56	0.20	-	24	-
Total		8-12 AM	5,616	131	0.061	343	0.0076	-	43	-
						756			145	
Deer	Dec. 1-5/80		1,700	35	0.143	243				
	Oct./80-Jan./81 [excluding Dec. 1-5]		30,260	390	0.044	1,319				
Total						1,562				
						[+451]				15 <sup>2/</sup>

<sup>1/</sup> Hunting pressure values combined for pheasant and cottontail rabbits after opening of pheasant season on November 15, 1980, as both species were often sought on the same hunting occasion.

<sup>2/</sup> Deer harvest estimates derived from ODMR Deer Check Station data.

Table 7. -- Deer Creek Lake project. Standard errors computed by the OCMRU for survey data reported in Table 5

Species hunted	Sampling schedule		Ave. no. hunters	Standard errors		
	Date	Hours		Rabbits	Pheasants	Squirrels
Rabbits	No. 1/80	10 AM-5 PM	0.377	0.042	-	-
	Nov. 2-14/80	10 AM-5 PM	0.090	0.032	-	-
Rabbits and pheasants	Nov. 15/80	9 AM-3 PM	1.0	0.100	0.320	-
	Nov. 16-30/80	10 AM-5 PM	0.157	0.029	0.014	-
	Dec. /80-Jan. /81	10 AM-3 PM	0.22	-	-	-
	Sept.	8-12 AM	0.0473	-	-	0.0159
Squirrels <sup>1/</sup>	Oct.	5-6 PM	0.1696	-	-	0.2143
		8-12 AM	0.0453	-	-	0.0111
Deer <sup>2/</sup>	Dec. 1-5/80	9 AM-2 PM	0.0111	-	-	-
	Oct. /80-Jan. /81	9 AM-2 PM	0.0149	-	-	-

<sup>1/</sup>Note: s.e. of  $\sum_{i=1}^n \bar{x}_i = \sqrt{\frac{2}{n}} \cdot [s.e.(\bar{x}_i)]$ , e.g., s.e. of  $\sum_{i=1}^n \bar{x}_i = 4.576 + 120 (.078) + 120 (.467) + 5,616 (.061) =$   
 $\sqrt{4576^2 (.0473^2) + 120^2 (.467^2) + 5,616^2 (.061^2)} = 334$

<sup>2/</sup>Deer harvest based on check station data.

ones) produces an overestimate (because the sample always includes a full lot), and the interaction of these problems is not easy to untangle. Due to this difficulty, the estimates of total number of hunters and total kill must be regarded with caution. They are certainly accurate enough to demonstrate the general trends in wildlife utilization at Deer Creek, but they cannot be considered completely unbiased.

Information concerning the length of the hunting trip, previous hunting experience on the area, hunting success, and distance traveled were routinely collected during each interview as indicated by the interview questionnaire (Figure 4). The total hunting effort expended during the 1980-1981 hunting season (September, 1980 through January, 1981) was estimated by the OCWRU survey at 10,218 hunter man-days, including 7,555 man-days for ring-necked pheasants and cottontail rabbits, 776 man-days for fox squirrels, 1,562 trips for white-tailed deer, and 345 man-days for waterfowl (Table 8).

On the average, hunters seeking pheasants (primarily) and rabbits traveled a greater distance than hunters seeking other species. Hunters traveling less than 40 km (25 mi) made up only 10 percent of the total pheasant hunting effort, while some 45 percent of the hunters traveled more than 80 km (50 mi). In contrast, the percentage of hunters traveling more than 80 km (50 mi) averaged only 25 percent for all hunting activities.

Pheasant and rabbit hunting were the most popular hunting activities. Results of the survey indicated that more than 7,500 hunting man-days were spent on project lands for both species. It was evident from a perusal of the OCWRU hunter survey data that the bulk of this hunting effort was directed towards pheasants. Rabbit hunting effort after the opening of the pheasant season was probably secondary. For example, the estimated rabbit hunting pressure on the opening day of the rabbit season (November 1, 1980) and subsequent 13 days

Figure 4. -- Deer Creek Lake project. Hunter survey questionnaire

We are conducting a survey to estimate wildlife recreational use at Deer Creek and we'd like your help. Your answers will help tell us which areas are best for different species and we can try to improve these and the other areas to make your hunt more enjoyable and increase the wildlife populations on the area.

If you have any questions or additional information, please call Dr. Jonathan Bart or Karen Cunningham at Ohio State University at 422-5762.

Thank you for your assistance.

1. How long have you been hunting today? (answer in hours)
2. How many people were in your party?
3. Which area were you hunting in? (give letter or letters of the appropriate compartments - see map)
4. Which species did you come here to hunt?
5. Did you have any success? YES or NO
6. If your answer was yes, please give the number of animals, the species, and the area in which each was caught (e.g. 3SqA = 3 squirrels caught in compartment A)
7. Is this your first hunt or first year of hunting? YES or NO
8. If your answer was no, how many years have you been hunting here at Deer Creek?
9. Do you usually come to hunt for just one species? YES or NO
10. If your answer was yes, which species?
11. How many times a year do you usually come here to hunt?
12. Have you noticed a decline in any of the wildlife populations here at Deer Creek? YES or NO
13. If your answer was yes, which species do you think have been affected?
14. How long do you think this decline has been going on?
15. Do you have any explanation for this decline?
16. How far did you travel to hunt here today?
17. Please give your county and state of residence.
18. Do you have any suggestions for improving Deer Creek State Park and Wildlife Area?

Table 8. -- Deer Creek Lake project. OCMRU survey estimates of hunting pressure (number of hunter man-days and hours), hunter experience levels, and one-way travel distance range, 1980-81 hunting season (September, 1980 through January, 1981)

	Estimated no.		Ave. no. hrs./man-day	Total hrs. hunted	Yrs. hunted on area (% of total hunters)		Ave. one-way travel distance [km (mi)]			
	No.	%			1st yr.	2 - 5	0-40 (0-25)	41-80 (26-50)	80 (50)	
Rabbits only	1,522	15	-	-	-	-	-	-	-	-
Pheasants and rabbits	6,033	59	-	-	-	-	-	-	-	-
Subtotal	7,555	74	2.50	18,888	33	38	29	10	45	45
Squirrel	756	7	2.39	1,807	34	52	14	20	80	0.0
Subtotal	8,311	81.3	2.49	20,695	33	40	27	12	53	35
Deer	1,562	15.3	3.47	5,420	26	53	21	50	50	0.0
Waterfowl	345	3.4	3.10	1,070	38	50	13	25	37.5	37.5
Total	10,218	100	2.66	27,185	32	42	26	20	55	25

1/ Includes an estimated hunting pressure of 1,522 hunting trips and harvest of 214 rabbits prior to the opening of the pheasant season plus an additional 6,033 hunting trips and a harvest of 225 rabbits and 492 pheasants after the opening of the pheasant hunting season on November 15.

2/ No estimate of harvest was possible due to small sample size.



(through November 14) totaled some 1,522 hunter man-days. Hunting pressure estimated for a comparable period after the opening of the pheasant season (November 15 through November 30) was three times as great, 4,207 hunter man-days.

Information obtained from resident ODNR personnel stationed on the project area indicated that the stocked game farm birds supported the bulk of the pheasant harvest (Dave Graham, ODNR, pers. comm., 1982). Resident birds, although abundant, contributed only marginally to the total pheasant harvest as they migrated to nearby park areas closed to hunting with the onset of the hunting season. The importance of the stocked game farm birds was emphasized in the OCWRU report as follows (10):

Thus, whatever the inferiorities of game farm birds, there seems to be no alternative to a release program at Deer Creek if current hunter demand is to be satisfied.

Squirrel hunters comprised the smallest segment of the total post-impoundment hunting effort (756 man-days) at the Deer Creek Lake project. However, squirrel hunting was believed to be far more prevalent in post-impoundment years than prior to project construction (op. cit.), viz:

Despite their low priority status, squirrels provide far more sport at Deer Creek than they did in 1960 or would today had the area remained in private ownership. They were seldom hunted in the area in 1960 according to the 1961 USFWS report; in 1980 an estimated 145 squirrels were taken during 756 trips, and this was 66 percent of the sustainable harvest indicating that the species is being utilized at near its maximum level. It is interesting to note that success/hour for squirrels (.10) was four times higher than for pheasants or cottontails and 35 times higher than for deer.

Deer hunting participation in post-impoundment years greatly exceeded without-the-project levels (op. cit.), viz:

The improvement in habitat suggests that the harvest would be

about twice the "without-the-project" projected level). In fact, though, the actual harvest was at least 15 (based on deer check station results), more than 7 times the level predicted on the basis of habitat alone. Such high harvest levels are not uncommon on public hunting lands. Several factors are probably responsible. Deer spending part of their time on private lands, where hunting pressure is generally low, may be shot when they venture onto the public land; a large herd may use the area as a refuge from which to move onto private land to feed; and even if hunting pressure does drastically reduce the herd, deer from surrounding private land are likely to immigrate before the next hunting season. It is important to recognize that these factors as well as the statewide increase in deer hunting have greatly affected deer hunting on the area. Even without the Deer Creek project, deer hunting would certainly be more popular now than it was in 1960 (hunting trips per year for deer were estimated at 0). But neither the population, the hunting demand (1,500 visits), nor the harvest would be as high if the land had remained in private ownership.

Post-impoundment consumptive use of other wildlife species found on the Deer Creek Lake project area was described in the OCWRU reports as follows:

Other species. Two other consumptive uses of wildlife - waterfowl hunting and trapping - have remained fairly minor activities at Deer Creek. The project inundated about 8 miles of Deer Creek which prior to project construction had supported some duck populations and duck hunting (estimated at 141 visits/year). Like most reservoirs, the Deer Creek reservoir does not seem to be particularly good waterfowl habitat. In 1980, an estimated 345 waterfowl hunting trips were made, probably not too different from use of the area had the reservoir not been installed. Thus the project appears to have had little effect on duck hunting. The trapping situation is similar. Pressure was fairly low in 1960 (estimated 200 pelts per year) and by 1980 had not grown much more than could be accounted for by the considerable increase in fur prices in recent years. The estimated take, based on interviews with 2 trappers and a local fur dealer, was about 500 pelts (mainly muskrat) in 1980.

#### Public use surveys (non-consumptive)

Although non-game wildlife species probably increased in abundance in post-impoundment years as a result of favorable changes in habitat composition, the OCWRU survey indicated only minor visitor participation in non-consumptive wildlife-associated activities (10), viz:

Numerous other species, of course, were affected by the project. The avian community probably increased in diversity and abundance as agricultural fields were replaced by smaller, more varied patches of reverting old fields. The same is probably true of most other groups of animals. However, birdwatching and other contemplative uses of wildlife are not pursued in great degree at Deer Creek and so no effort was made to study changes in these groups of animals in detail.

Records collected by the ODNR certified a total annual campground use by approximately 46,236 individuals during calendar year 1980. The campers made considerable use of two hiking trails maintained by the ODNR on the project area. An average of 11.3 hikers per day were estimated by the OCWRU to have used either the Campground or Boat Ramp hiking trails for a total usage of 1,972 days during the survey period, which extended from May 22 through December 7, 1980 (Table 9).

Activities sponsored by the Deer Creek State Park Naturalist were also popular with project visitors. A total of 4,407 individuals participated in such activities from June 14 through August 31, 1980 (Table 10). However, few of these activities were clearly associated with wildlife-associated recreation.

#### Wildlife Resources--Evaluation of Planning Input

Six separate reports concerning the Deer Creek Lake project were prepared by the FWS over a 16-year period extending from November, 1948 through November, 1964. Each of these FWS reports was prepared in response to changes in project objectives and associated engineering design which occurred over the years.

The initial (November, 1948) FWS report evaluated impacts on fish and wildlife resources anticipated from construction of a single-purpose project designed by the CE solely for temporary flood storage. The CE development plan made no

Table 9. -- Deer Creek Lake project. Estimated trail use on the campground area and boat ramp area trails from May 22, 1980 through December 7, 1980

Month	Campground Trail			Boat Ramp Trail			Total	
	No. days available	Ave. no. hikers/day	Total no. hikers	No. days available	Ave. no. hikers/day	Total no. hikers	Ave. no. hikers/day	Total no. hikers
May	7	22.57	158	10	8.80	88	28.94	246
June	19	14.26	271 <sup>1/</sup>	30	6.47	194	23.8	465 <sup>1/</sup>
July	23	7.65	176 <sup>2/</sup>	31	2.06	64	8.88	240 <sup>2/</sup>
August	31	12.0	372	31	1.77	55	13.77	427
September	30	6.67	200	30	3.20	96	9.86	296
October	31	3.97	123	31	3.19	99	7.16	222
November	11	2.64	29	30	1.27	38	3.27	67
December	-	-	-	7	1.28	9	1.28	9
Total (ave.)	151	8.74	1,329	200	3.22	643	11.3	1,972

<sup>1/</sup>Minimum estimate, as registration forms were not available to hiker on 11 days during June at campground trail.

<sup>2/</sup>Trail use prohibited on campground trail over 8 days period due to severe storm damage.

Table 10. -- Deer Creek Lake project. Attendance at naturalist's program at Deer Creek State Park during 1980  
(June 14 - August 31)

Program	Number of participants for week/ending:											Totals
	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/31	
Hikes	48	82	76	57	16	50	24	18	70	36	32	509
Bike hikes	17	17	31	26		16	9	13		15	16	143
Dam tours	28	30		34		27	27	27	32		29	234
Movies	123	41	110		58	50		36	43		88	549
Slide talks	11	11	97	84	30	26	19	18	30	16	29	360
Talks				13				39	37	22	13	124
Jr. naturalists	11	20	47	21	8	38	7	18	54	32	13	269
Nature center	7	19	78	34	48	89	50	82	55	47	39	548
Astronomy	20		6	27	17		5		4			79
Campfire			66	32	27	53	26	20	22	16		262
Compass use		3	9	4		13			4			33
Indian lore											24	24
Clean up		30	7	5	2		1					45
Crafts									29	18	19	66
Roving misc.	17	22	35	63	74	70	10	51	57	2	29	430
Group activities		30	1	80	35	24	27	8	27			232
Totals	254	305	562	480	315	456	205	330	464	204	331	4,407*

\*Includes an additional 500 participants in a mid-summer festival featuring an ice cream social with a blue-grass band, water sports and games.  
1/ Brownie troupe - hike.  
2/ Cub Scout troupe - games and nature study.  
3/ Head Start workers - study of wild edibles.  
4/ Rotary Club of Mt. Sterling - talk.  
5/ Tour of local rocks.  
6/ Group from Washington Courthouse - nature program.

provision for a minimum permanent pool. Only marginal damage to wildlife resources was predicted to occur within the project impact area, as the temporary 1,085 ha (2,680 ac) flood pool was expected to be dewatered as quickly as possible after each flooding occasion. The FWS evaluation of project impacts on wildlife resources contained in the report was superficial, consisting primarily of an unsupported statement that without-the-project wildlife resource values assessed at \$400 would be reduced to \$300 with the project in place. No attempt was made in the November, 1948 FWS report to document pre-construction or post-project wildlife density levels and/or related hunting man-day use anticipated within the project area.

Subsequent FWS reports, however, were more detailed and provided specific estimates of project impacts on wildlife density and hunting man-day use which could be anticipated by the implementation of the various development plans proposed by the CE over the years.

Also, these FWS reports contained worthwhile recommendations designed to maximize post-project wildlife values. For example, the July 12, 1961 FWS preliminary draft report contained specific recommendations to the CE that lands obtained in fee for the project be fenced at project expense and licensed to the ODNR for wildlife management purposes. Additional meritorious recommendations were proposed for wildlife resource mitigation and enhancement in two reports submitted later the same year (November 16, 1961). These more comprehensive reports discussed the role of the Deer Creek Lake project in relation to the CE's overall development plan for the Scioto River Basin. Six

reservoir sites (including Deer Creek Lake) were included in the CE's basinwide plan.

The FWS recommended the purchase and development of a 243 ha (600 ac) tract contiguous to the Deer Creek Lake project purchase area as partial mitigation for the loss of upland game hunting opportunity (1,670 man-days per year) expected from development of two other proposed reservoir sites (Mill Creek and Alum Creek Reservoirs). This recommendation appeared to be well conceived and appropriate for mitigation of predicted upland game resource losses. Upland game habitat available at the Deer Creek Lake project site, particularly for ring-necked pheasant, was far superior and more amenable to intensive wildlife management than could be provided by lands situated near the other proposed project sites located within the Scioto River Basin.

The FWS also recommended, as a waterfowl enhancement feature, the purchase of an additional 344 ha (850 ac) tract, plus the construction of a 24 ha (60 ac) sub-impoundment within the tract, to be managed by the ODNR primarily for waterfowl. An additional 2,700 waterfowl hunting man-days plus 1,320 hunting man-days for upland game species were expected as a result of implementation of the FWS recommendations.

For various reasons, these well-conceived November, 1961 FWS recommendations calling for land purchase and wildlife resource development beyond the authorized land acquisition zone were never implemented.

The need for additional project lands for mitigation of upland game resources was reduced considerably by interim changes in land acquisition policies which

resulted in the purchase of substantially more land than originally proposed (1), viz:

The Joint Army-Interior Land Acquisition Policy of June 1962 has resulted in plans for more land acquisition at Deer Creek. Under the new policy the entire flood pool plus buffer strip will be acquired in fee with the exception of some upper flood pool areas. This will result in about 1,000 acres of in-fee acquisition in contrast to the 2,810 acres that was originally estimated under the old policy. A good deal, probably about 2,500 acres, of this in-fee land acquisition will be usable for intensive public hunting area management. As a result, the project is now a more favorable project as far as upland game is concerned. As a matter of fact, increased land acquisition at all of the projects in the Scioto System would probably have resulted in the loss of our mitigation case even if Mill and Alum Creeks had not been lost to the Corps of Engineers.

In fact, the November, 1961 FWS report recommendation for the acquisition of the 243 ha (600 ac) tract at Deer Creek Lake project for mitigation of upland game resource losses anticipated from construction of the Alum Creek and Mill Creek reservoir projects became moot, as neither project was included in the final CE development plan finally approved for the Scioto River Basin (op. cit.), viz:

The Mill and Alum Creek projects, which are no longer part of the Corps of Engineers system, are by coincidence the two projects that justified the mitigation unit at the Deer Creek project. Since the Corps will not mitigate damages caused by a project they do not construct, it appears that we have lost our mitigation case.

Also, although approved by the CE, efforts to amend project authorization to include the acquisition and development of the recommended waterfowl management area were unsuccessful--primarily because of opposition by the United States Bureau of the Budget (op. cit.), viz:

The Fish and Wildlife Plan as outlined in our 1962 report was approved by the Corps of Engineers through the Chief of Engineers. However, the Bureau of the Budget recommended deferring authorization of the 1,000 acre waterfowl enhancement unit and the 60 acre sub-impoundment pending review by the Department of the Interior of future migratory waterfowl programs. This



Department of the Interior Review was requested so that the Bureau of the Budget could evaluate the contribution of our proposed waterfowl enhancement plan to the overall waterfowl program. The Bureau of the Budget also said that they were currently reviewing cost sharing at Federally constructed water resource projects as further reason for recommending deferring authorization. As a result of this action by the Bureau of the Budget, the Deer Creek project authorization was not modified to include our 1,000 acre extra land acquisition or the 60 acre sub-impoundment for waterfowl enhancement.

However, the possibility of providing the recommended Deer Creek Lake project waterfowl management unit was given a temporary reprieve by a suggestion contained in a letter from the Huntington District Engineer addressed to the FWS Ohio Area Office (12), viz:

Project authorization for the Deer Creek Reservoir was not modified to include the sub-impoundment feature. Pending legislation [Aspinall Bill, H.R. 9032] would, if enacted, authorize Federal expenditures at Federal water resource projects for migratory waterfowl development features. However, such legislation has not been passed, and no authority exists for the purchase of land for, or the construction of, migratory waterfowl developments at this time. Since our pre-construction planning is nearing completion and construction is expected to be initiated in FY 1965, justification and authority for the waterfowl features must be furnished in the near future or such features cannot be included in the project.

After due consideration, the FWS decided not to request the development of the previously recommended waterfowl management area (11), viz:

The waterfowl unit and sub-impoundment needs to be re-evaluated in the light of new conditions. Preliminary calculations indicate a marginal case in view of increased land costs and increased dike construction costs. Also to acquire the 565 acres needed to fill out our original waterfowl enhancement unit we will have to apply the 5-step procedure.

Collectively, the FWS reports submitted to the CE in 1961 and 1964 appeared to adequately address the wildlife resources problems posed by each of the various development regimes advanced by the CE over time. FWS recommendations for

mitigation and/or enhancement of wildlife resources were well-conceived and reflected timely and effective coordination between the CE, ODNR, and the FWS.

The FWS correctly predicted the accelerated trend in hunting man-day use which subsequently occurred within the project impact areas after completion of the Deer Creek Lake project. As documented by the OCWRU hunter survey conducted during the 1980-1981 hunting season, the project impact area supported an estimated total of 10,218 hunting man-days. A similar estimate of total hunting effort on project land, 10,500 hunting man-days, was reported by the ODNR in 1974 (13). This level of hunting effort constituted more than a twelve-fold increase over the 800 hunter man-days which the FWS anticipated would have occurred within the project impact area without the project.

However, the magnitude of the predicted increase in post-project hunting effort was substantially overstated for both upland game and waterfowl in the FWS reports. Hunting effort for upland game species (pheasants, rabbits, and squirrels) was estimated at 8,311 man-days during the 1980-1981 OCWRU survey, or some 66 percent lower than the 24,280 man-days predicted in the November 6, 1964 FWS report (Table 11). Hunting effort for waterfowl, estimated at only 345 man-days during the 1980-1981 OCWRU survey, was 83 percent lower than the 2,000 man-days predicted by the FWS.

On the other hand, the FWS failed to foresee the substantial increase in white-tailed deer abundance which occurred in post-project years. Deer were rarely found within the general vicinity of the project in pre-project years. However, contrary to FWS predictions that the project impact area would not afford any post-project hunting opportunity for deer, the OCWRU survey report

Table 11. -- Deer Creek Lake project. Comparison of post-project hunting man-day use predictions contained in the November 6, 1964 FWS report with post-impoundment occurrences as estimated by the OCMRU hunter-use survey conducted during the 1980-81 hunting season

Species	FWS predictions		Post-project occurrence		Difference	
	No. man-days		No. man-days		No. man-days	Percent change
Rabbits and pheasants	-		7,555		-	-
Squirrel	-		756		-	-
Total upland game	24,280		8,311		-15,969	-66
White-tailed deer	0		1,562		+1,562	-
Waterfowl	2,000		345		-1,655	-83
Total	26,280		10,218		-16,062	-61

estimated a total of 1,562 hunting man-days were spent exclusively in pursuit of deer during the 1980-1981 hunting season.

## FISHERY RESULTS AND DISCUSSION

### Fishery Resources--Pre-impoundment Predictions

Fishery resources associated with the Deer Creek Lake project were first described in a report prepared by the FWS for submission to the CE in November, 1948 (4). At this early juncture, the project was designed to provide only flood control storage [ $9.25 \times 10^7 \text{ m}^3$  (75,000 ac ft)], which would intermittently impound some 16 km (10 mi) of Deer Creek behind the dam at maximum flood control pool. CE project operational plans called for dewatering the flood pool as quickly as possible following each flooding occasion.

Net project impacts on fishery resources were assessed at zero by the FWS in their November, 1948 report. The minor impairment of fisheries resources predicted upstream from the dam was expected to be offset by commensurate improvement in the fishery resources over a 32 km (20 mi) downstream stretch as a result of more stable water levels below the dam. The pre-project stream fishery above the proposed dam (valued at \$6,000) was expected to increase by \$600 after project construction. This brief report did not provide any man-day use projections nor offer any discussion as to how the assessed monetary values were derived.

The next FWS report was not submitted to the CE until July 12, 1961, some 13 years later. The Deer Creek Lake project was included as one of eight flood control projects within the Scioto River Basin under consideration for development by the CE. CE basinwide planning had not, as yet, advanced sufficiently to recommend specific projects for development (5), viz:

The project is one of eight impoundments under consideration as flood control measures needed for protection in the Scioto River

Basin, Ohio and also to aid the reduction of flooding on the Ohio River at and below the mouth of Scioto River at Portsmouth, Ohio. It is our understanding that a group of units will be chosen from among eight impoundments and that these several units will be recommended in your Survey Report on Scioto River Basin.

In view of the tentative nature of the proposed project development, the FWS intended their July 12 report to be preliminary and subject to change on receipt of more specific development plans from the CE (op. cit.), viz:

This letter is not intended for inclusion in your Survey Report. A single integrated Reconnaissance Report will be prepared on fish and wildlife resources as they would be affected by the flood control plan for the Scioto Basin. This will be initiated after advice is received as to which units will be recommended for flood control....Monetary estimates of net incidental benefits are based on values applied to existing and/or potential hunter and fisherman day use without regard for other possible projects in the basin. Since this evaluation is on an individual project basis, it may require some adjustment in our overall Basin Reconnaissance Report.

Physical characteristics of the proposed Deer Creek Reservoir pertinent to fishery resources were described in the July 12, 1961 FWS report as follows:

The following project information, extracted from preliminary data provided by your office on January 27, 1961, serves as the basis for this preliminary evaluation.

The damsite is in Pickaway County at mile 22.2 on Deer Creek, the reservoir area encompassing portions of a 9.7-mile reach of Deer Creek Valley in Pickaway, Madison, and Fayette Counties. Streambed elevation at the damsite is 770 feet m.s.l. Primary outlet works in the dam would consist of five gated sluices five feet square discharging into a stilling basin, plus a 30-inch low-flow sluice. A 760-acre minimum pool would be held at elevation 786 and would inundate permanently some 3.5 miles of Deer Creek....

Approximately 4.5 miles of Deer Creek, from immediately upstream from the minimum pool to a point about one mile upstream from Yankeetown Road crossing, would be included in the 5-year flood and in-fee zone. Full flood pool spillway crest at elevation 838 would include a total area of 3,180 acres....

Deer Creek supported a diverse fish community containing important sport fish species within the area of project influence (op. cit.), viz:

Deer Creek, in the project area of influence, is one of the better stream fisheries in this portion of Ohio, having dependable flow throughout most years and a favorable ratio of pools to riffles. Good populations of desirable sport fishes are sustained in the project reach. Some of the more important resident species include: shovelhead and channel catfishes; smallmouth, largemouth, and Kentucky spotted basses; rock bass; various sunfishes; black and white crappies; and yellow, brown, and black bullheads. Suckers are an important species during spring run periods.

Recreational fishing pressure supported by Deer Creek also was considered to be high (op. cit.), viz:

Fisherman utilization is high. In addition to conventional rod and reel angling, Deer Creek also supports trotline fishing. Average annual fisherman use on Deer Creek within and below the project site is 300 angler days per mile. Some 16 miles of Deer Creek are within the area of significant influence of Deer Creek Reservoir, including the eight miles below the proposed structure to Williamsport, Ohio. Without the project the average total annual fisherman use of this 16-mile reach of Deer Creek would be 4,800 fisherman days.

An attractive and substantial recreational fishery was expected to develop within the project impact area, assuming implementation of FWS fishery management recommendations contained in the report. These fishery management recommendations featured the development of minimum public access and boat launching facilities to the lake and tailwater at an estimated cost to the project of \$34,700. Additional fishery management recommendations at a cost of \$16,180 were specified in the FWS report as follows:

- (a) Cost of carp removal from the reservoir for the first year only would be about \$300...
- (b) Fish attractors made of logs should be placed in the minimum pool if all woody growth is removed from that area. Patches of undisturbed woody growth in the pool area would be preferable as fish habitat. Approximate total cost for fish attractors would be \$300...

- (c) Cost of establishing muskellunge in the minimum pool during the first 5-year period after dam closure would be about \$5,730...
- (d) Cost of establishing walleye pike in the minimum pool during the first 5-year period after dam closure would be about \$2,250...
- (e) Stocking of largemouth bass during the first year only would cost about \$7,600.

The total initial cost of implementing the FWS fishery management recommendations was estimated at \$50,880 (fish control, introductions, and launching facilities). In addition to these initial costs, the cost of post-impoundment fishery surveys and periodic supplemental stocking of muskellunge and other fish species was expected to average \$1,000 per year.

Fishery resources associated with the Deer Creek Lake project were discussed further in two FWS reports subsequently submitted to the CE on November 16, 1961. These reports consisted of a brief letter-report (6), plus a more comprehensive substantiating report (7).

Several slight changes in the physical parameters proposed for the Deer Creek Lake project had been adopted by the CE in the interim between submission of the July and November, 1961 FWS reports. These changes included a reduction in the size of the proposed minimum pool from 308 ha (760 ac) to 271 ha (670 ac), and a concurrent increase in length of the stretch of Deer Creek located within the project impact area above the head of the minimum pool from 7 km (4.5 mi) to 8 km (5.0 mi). Provision for a minimum instantaneous discharge from the project also was noted for the first time (7), viz:

Minimum instantaneous flow from the reservoir will be 10 c.f.s. During normal flow periods, releases will be greater, however. Under normal conditions, releases will be equal to inflow minus pool evaporation losses.



Also, the November 16, 1961 FWS substantiating report recommended the construction of a 24 ha (60 ac) sub-impoundment, primarily as a waterfowl enhancement feature. However, the sub-impoundment was expected to provide peripheral fishing benefits as well (7), viz:

Subimpoundment and Dike--The subimpoundment for waterfowl management would have a surface area of about 60 acres. It would require some 600-700 acre-feet of the flood storage capacity of Deer Creek Reservoir (less than 1%)...A simple control structure would be needed to allow outflow of Clarks Run and also to permit drawdown of the subimpoundment. The dike and outlet works would be constructed of concrete to withstand damages during periods when the subimpoundment was overtopped by flood storage; on the average of once every 3-4 years...The subimpoundment would be stocked with largemouth bass, bluegills, and crappies ...Some 5,400 days of fishing would be supported by the waterfowl subimpoundment.

The November 16, 1961 FWS report predicted that the project would support an average of 115,375 fishing man-days per year valued at \$173,063 over the designated 50-year life of the project (Table 12). This predicted level of fishing pressure amounted to a 24-fold increase over the average annual number of without-the-project fishing man-days (4,800) and monetary value (\$7,200) afforded by the 26 km (16 mi) section of Deer Creek within the project impact area.

The total predicted post-project recreational fishery included some 89,800 fishing man-days per year [331 man-days/ha (134/ac)], valued at \$134,700, which was expected to develop in the 271 ha (670 ac) minimum pool of Deer Creek Lake. Construction of the proposed 24 ha (60 ac) waterfowl sub-impoundment was expected to provide 5,400 angling man-days per year valued at \$8,100.

An additional 20,175 stream fishing man-days per year, valued at \$30,263, were

Table 12. -- Deer Creek Lake project. Summary of predicted post-project changes in recreational fishing man-day use and associated monetary values predicted in the November 16, 1961 FWS reports (6, 7)

	Without-the-project	With-the-project	Net (with-the-project)
<b>Deer Creek (stream)</b>			
<b>Above damsite</b>			
Length [km (mi)]	13 (8)	8 (5)	-5 (3)
Fishing man-days			
Number	2,400	15,000	+12,600
No/km (no/mi)	185 (300)	1,929 (3,000)	-
Monetary value (\$)	3,600	22,500	+18,900
<b>Below damsite</b>			
Length [km (mi)]	13 (8)	12.5 (7.75)	-0.5 (0.25) <sup>1/</sup>
Fishing man-days			
Number	2,400	5,175	+2,775
No/km (no/mi)	185 (300)	414 (668)	-
Monetary value (\$)	3,600	7,763	+4,163
Total stream length [km (mi)]	26 (16)	20.5 (12.75)	-5.5 (3.25)
Total no. stream man-days	4,800	20,175	+15,375
Total monetary stream value (\$)	7,200	30,263	+23,063
<b>Deer Creek Lake</b>			
Area [ha (ac)]	-	271 (670)	+271 (670)
Fishing man-days			
Number	-	89,800	+89,800
No/ha (no/ac)	-	331 (134)	-
Monetary value (\$)	-	143,700	+143,700
Total no. man-days	4,800	115,375 <sup>2/</sup>	+110,575
Monetary value (\$)	7,200	173,063 <sup>2/</sup>	+165,863

<sup>1/</sup> Assumes that 0.4 km (0.25 mi) of Deer Creek would be occupied by the dam.  
<sup>2/</sup> Includes 5,400 fishing man-days valued at \$8,100 to be provided by construction of a proposed 24 ha (60 ac) waterfowl sub-impoundment.

expected to occur in sections of Deer Creek located within the project impact area. Most of the post-project stream fishing man-day use (15,000 man-days valued at \$22,500) was expected to be generated within the 8 km (5 mi) stretch of Deer Creek located immediately upstream from the proposed lake. This predicted level of fishing pressure amounts to an exceptionally high value of 1,929 man-days/km (3,000 man-days/mi), a ten-fold increase over the 185 man-days/km (300 man-days/mi) predicted without the project. The reasons advanced by the FWS for the predicted increase in angling pressure upstream from the lake were described in the November 16, 1961 FWS report as follows:

Increased angler use over without the project conditions would result from upstream migration of muskellunge and walleyes from the minimum pool, insured free public access, provision of necessary parking and launching facilities, and opportunity for boat float trips as well as stream bank angling. The habitat would be slightly damaged by periodic flood storage.

A considerably more modest annual increase in post-project angling pressure was predicted within the 12.5 km (7.75 mi) tailwater. Some 5,175 fishing man-days per year [amounting to 414 man-days/km (668 man-days/mi)] were predicted for the tailwater section with the project in place as compared to 2,400 fishing man-days per year [185 man-days/km (300 man-days/mi)] without the project.

An overall net average annual increase of 110,575 fishing man-days valued at \$165,862 was predicted with the project in place. The value of an individual man-day of fishing, \$1.50, was based on values cited in the May 24, 1960 Report of the Panel on Recreational Values of the Subcommittee on Evaluation Standards, Inter-Agency Committee on Water Resources (14).

The net average annual value of the predicted increase in fishing man-day use within the project impact area attributed to project construction (\$165,826)

was several times greater than the estimated total annualized cost of implementing the entire fish and wildlife plan recommended by the FWS (7), viz:

Costs of the Fish and Wildlife Plan

Initial Costs

In-fee acquisition 850 acres	\$297,500
Higher estate in 100 acres	15,000
Dike construction	237,000
Initial fishery management	16,685
Initial wildlife management	2,500
Access and control facilities	51,840
Total	\$620,525
(rounded)	\$620,500

Average Annual Costs

Fishery management with access OM&R	3,850
Wildlife management with access OM&R	25,160
Total	\$ 29,010
(rounded)	\$ 29,000

The annual equivalent of the total initial cost (\$620,500) based on a 50-year project life would be \$22,424. On a completely annual basis, therefore, full cost of implementing the plan would be \$51,420.

The next and final FWS planning report which addressed project impacts on fishing resources was submitted to the CE May 14, 1964. This FWS Special Letter Report dealt exclusively with planning components pertinent to the tailwater recreational fishery (15).

Although noting that a minimum instantaneous flow greater than that proposed by the CE [ $0.28 \text{ m}^3/\text{sec}$  (10 cfs)] would be desirable, the FWS acknowledged that the proposed flow would be adequate to support a good tailwater fishery (op. cit.), viz:

You have specified that downstream minimum instantaneous releases will be equal to normal inflow minus pool evaporation but never less than 10 c.f.s. These normal stream flows below the dam will be reduced an amount equal to pool evaporation. This

stream flow reduction will not affect fish habitat downstream. The historic minimum discharge recorded on Deer Creek is 1.6 c.f.s. Since the minimum discharge from the reservoir will be 10 c.f.s., the project will ensure that this historic low will always be exceeded. Since flows of this volume are common in late summer at the damsite, this feature will be beneficial to the downstream fishery. Although greater flows would be desirable, we understand that physical project limitations make greater releases impossible. Releases presently planned, however, will result in a good tailwater fishery....The Deer Creek Reservoir tailwater fishery will benefit if warm-water releases are provided downstream, particularly during the summer months.

Factors contributing to the proper location and capacity of reservoir water release facilities are addressed (op. cit.), viz:

Water depth at the dam at minimum pool will be about 20 feet and at full flood pool about 60 feet. The water quality may vary at different levels. In order to provide for flexibility in the elevation from which reservoir water may be released downstream, a low flow by-pass or by-passes capable of passing at least 200 c.f.s. should be located with invert elevation at 786' or 10' below the elevation of the top of the minimum pool.

The release of flood waters from bottom sluice gates results in substantial fish loss at some reservoirs. Fish are swept by high velocity currents through the sluice gates into the tailwaters. The sudden decrease in external pressure causes damage to vital organs. This fish loss can be moderated by the manner in which the gates are operated. Opening several gates a small amount will result in a reduction of fish loss through the sluices as compared with opening one gate an amount sufficient to handle the entire downstream release. The manner in which flood water is released should be coordinated with the Ohio Division of Wildlife.

Suggestions for refinement of previously submitted recommendations concerning the development of adequate fisherman access to the tailwaters were presented (op. cit.), viz:

Permitting fisherman use of the Deer Creek Reservoir and providing sufficient tailwater access facilities was discussed and provided for in the Fish and Wildlife Plan in our Detailed Scioto Basin Report of November, 1961.

To further refine our Fish and Wildlife Plan, the parking lot should have a capacity of at least 60 cars, and a strip at least

1,000 yards long and 50 yards wide should be acquired in fee on each side of the stream below the dam.

#### Fishery Resources--Post-impoundment Occurrences

Although not previously acknowledged in pertinent FWS planning reports submitted to the CE in 1961 and 1964, a decision subsequently was made by the CE to incorporate a summer recreational pool in the plan finally approved for the Deer Creek Lake project. Prior project design provided only for a minimum pool elevation 242.6 m (796 ft) msl. As finally constructed, Deer Creek Lake covers approximately 517 ha (1,277 ac) at summer recreational pool elevation 246.6 m (810 ft) msl. The lake averages 5 m (16.5 ft) in depth with a shoreline length of 32 km (20 mi).

An attempt is made to maintain the lake at the summer recreational pool elevation from mid-April through early fall. The lake is drawn down in the fall and held (as nearly as possible) at minimum pool elevation from December 1 through March 31, to provide winter flood control storage capacity. Initiation of the fall drawdown to minimum pool has commenced as early as September 13, in 1976, and as late as November 18, in 1974 (3). The vertical drawdown to minimum pool amounts to 4.25 m (14 ft), which results in a 43 percent reduction in surface area and a 57 percent reduction in lake volume.

Major components of the fishery resources associated with the Deer Creek Lake project have been monitored annually by the ODNR since impoundment in May, 1968.

#### Early fisheries management history

Prior to impoundment, numerous fish attractors (brush piles and felled trees) were developed during lake bed clearing operations. Trees and brush were also left standing in some areas. Seven strategically located test net and seining locations were carefully cleared and appropriately identified. Scheduled plans to selectively net and remove non-game fish species from Deer Creek within the proposed lake basin prior to impoundment were thwarted by extremely heavy rainfall (16), viz:

Extremely heavy rainfall during initial filling in May, 1968 resulted in filling of Deer Creek Lake to 27 feet above seasonal pool. The scheduled fish removal project for the spring of 1968 was not conducted, as nets could not be set until July. At that time, numbers of rough fish taken did not justify a removal project.

In an effort to establish a strong predator base, the ODNR initiated a substantial stocking program during the first year of impoundment (1968). A million walleye fry, 115,000 muskellunge fry, 17,183 largemouth bass fingerlings, and 15,000 striped bass fingerlings were stocked during 1968 (Table 13). Additional fish were stocked annually through the spring of 1971, including 1,000,000 walleye fry in 1969, 300,000 in 1970, and 1,000,000 in 1971. Muskellunge were stocked again in 1969 (6,000 fry and 1,053 fingerlings) and 1970 (1,875 fingerlings). An additional 20,077 largemouth bass fingerlings were stocked in 1969 and 60,000 more were stocked in 1970. One hundred and fifty adult and 6,000 fingerling channel catfish were stocked in 1969.

#### Water quality

Deer Creek Lake is a fertile, highly productive body of water, reflecting the agricultural nature of the watershed, which lies entirely within the high-lime Wisconsin till region. Specific conductance, pH, alkalinity, and hardness are

Table 13. -- Deer Creek Lake project. Fish stocking summary, 1968-1980. (Number of fry expressed in thousands; actual number presented for other size classifications)

Species and size	1968	1969	1970	1971	Year and number stocked					1978	1979	1980
					Subtotal	1975	1976	1977	1978			
<u>Nalleye</u>												
Fry	1,000	300	1,000	900	3,200	2,000	-	-	-	-	-	-
Fingerling	-	-	-	-	-	-	-	76,760	-	-	-	-
<u>Muskellunge</u>												
Fry	115	6	-	-	121	-	-	-	-	-	-	-
Fingerling	-	1,053	1,875	-	2,928	-	1,250*	-	-	-	90*	400
<u>Largemouth bass</u>												
Fingerling	17,183	20,077	60,000	-	97,260	13,659	13,200	40,173	-	-	-	-
<u>Striped bass</u>												
Fingerling	15,000	-	-	-	15,000	-	-	-	-	-	-	-
<u>Channel catfish</u>												
Fingerling	-	6,000	-	70,105	76,105	41,000	-	-	-	-	-	-
Adult	-	150	-	-	150	-	-	-	-	-	-	-
<u>Saugrey</u>												
Fingerling	-	-	-	-	-	-	-	-	-	75,123	244,671	43,170
Advanced fingerling	-	-	-	-	-	-	-	-	-	555	-	-

\*Tiger muskellunge (muskellunge x northern pike).



all relatively high. Nutrient loading is also high. Chlorophyll a data collected by the CE indicate that Deer Creek Lake is the second most productive of the 30 lakes within the Huntington District, CE. However, no noxious algae blooms have been noted.

Water quality in the lake is generally adequate for all aquatic organisms. The lake generally is weakly stratified by early summer of most years. Stratification becomes increasingly severe in midsummer and fall, with anoxic conditions in the hypolimnion, although the time, intensity, and duration of stratification vary with hydrometeorological parameters.

Floodwaters are discharged through low-level sluices located at elevation 235.3 m (772 ft) msl. Minimum low flow requirements are met by discharge from a single intake port located in the hypolimnion at elevation 239.6 m (786 ft) msl, which is some 7.3 m (24 ft) below the lake surface.

The quality of the water discharged in the lake tailwater has generally been adequate for aquatic organisms, although excessive iron and manganese have been observed in the water released during periods of lake anoxia in late summer and fall. Minimum low flow discharges from the lake have generally exceeded the minimum requirement [ $0.28 \text{ m}^3/\text{sec}$  (10 cfs)] since impoundment. The most lengthy deviation was encountered during May and June, 1976, when the mean monthly discharge from the lake averaged  $0.25 \text{ m}^3/\text{sec}$  (8.7 cfs) each month. The minimum discharge was  $0.19 \text{ m}^3/\text{sec}$  (6.8 cfs) in both months. No fish kills have been observed in the tailwater at any time since impoundment.

#### Fish community status--spawning success

The fish community of Deer Creek Lake has been sampled annually by the ODNR since impoundment in the spring of 1968. Fish reproduction was monitored annually by use of small [4.6 x 1.8 m (15 x 6 ft) and 6.4 mm (0.25 in) mesh] hand seines from 1968 through 1977. Most of the samples were obtained during July of each year. An 18.4 x 2.4 m (60 x 8 ft), 6.4 mm (0.25 in) mesh bag seine was utilized for the 1978 collections. Electrofishing gear, powered by a boat-mounted 250-275 volt AC generator, was used from 1978 through 1980.

Seining effort was minimal for most years. The length of shoreline sampled with the small 4.6 m (15 ft) seine averaged approximately 200 m (650 ft) annually and ranged from a maximum of 975 m (3,200 ft) in 1968 to only 64 m (210 ft) in 1970 (Table 14). The small sample size precluded any statistically significant conclusions regarding the relative success of reproduction from year to year. Also, the absence of a young-of-the-year of a particular species may have been attributable to insufficient sampling rather than to a failure to spawn successfully. However, the collections obtained in July 1968, using the 18.3 m (60 ft) bag seine, were more substantial.

Based on the presence or absence of young-of-the-year fishes collected each year, largemouth bass and bluegill exhibited the most consistent reproductive success. Young-of-the-year of both species were represented in collections made each year of the 12-year sampling period with the exception of 1971. Young-of-the-year smallmouth bass were collected only during the first year of impoundment (1968) and during the last three years of the sampling period from 1978 through 1980. Spotted bass were collected in substantial numbers only during 1968. White bass were collected only infrequently (1975 and 1978),

Table 14. -- Deer Creek Lake. Summary of young-of-year fish collected during July by ODMR, 1968-1980. Collections made from 1968 through 1977 were obtained by shoreline seining with a 4.6 x 1.8 m (15 x 6 ft) seine [6.4 mm (0.25 in)]. Collections made in 1979 and 1980 were obtained by electrofishing with a boat-mounted 250-275 volt AC generator. A 18.3 x 2.4 m (60 x 8 ft) 6.4 mm (0.25 in) mesh bag seine was utilized in 1978

Year	Shoreline length		Number young-of-year collected											Gizzard shad
	M sampled	Ft	Largemouth bass	Smallmouth bass	Spotted bass	White bass	White crappie	Sunfish <sup>1/</sup>	Carp	Suckers <sup>2/</sup>				
1968	975	3,200	5	1	101	-	40	336	533	27	2,969			
1969	123	405	1	-	-	-	8	109	4	200	-			
1970	64	210	30	-	-	-	82	139	-	6	22			
1971	76	250	1	-	-	-	-	2	-	-	86			
1972	85	280	-	-	-	-	1	-	-	9	208			
1973	95	280	8	-	-	-	-	8	1	-	1,618			
1974	178	585	18	-	2	-	2	3	22	59	1,261			
1975	107	350	2	-	-	1	2	9	4	14	1,135			
1976	123	405	3	-	-	-	-	20	3	21	374			
1977	160	525	16	-	-	-	14	8	-	7	180			
1978	533	1,750	117	2	7	392	907	337	2	107	-			
1979	12 1/2 hrs. <sup>3/</sup>		10	1	-	-	2	23	-	-	3			
1980	4 3/4 hrs. <sup>3/</sup>		84	1	-	-	1	33	-	-	5,472			

<sup>1/</sup>primarily bluegill, with lesser numbers of longear sunfish, green sunfish, orange spotted sunfish and pumpkinseed sunfish.

<sup>2/</sup>primarily golden shiner and quillback.

<sup>3/</sup>Only the length of sampling period was recorded (no indication of the length of the shoreline sampled).

possibly as a consequence of their pelagic habitat distribution, which made them less vulnerable to shoreline seining.

Gizzard shad young-of-the-year were collected in greater numbers than for any other single species. Successful spawning was noted each year with the exception of 1969 and again in 1978.

Sucker reproduction was noted in nine of the 12 years of record. Young-of-the-year carp appeared in seven of the annual collections and were particularly abundant during the first year of impoundment.

#### Adult fish community

Adult and intermediate-sized fishes were sampled annually by the ODNR from 1968 through 1980. Sampling from 1968 through 1977 was accomplished with 1.8 m (6 ft) and 4.3 m (14 ft), 5 cm (2 in) stretch-mesh fyke nets set overnight in representative areas of the lake. Electrofishing gear was used to sample the fish community from 1978 through 1980.

Deer Creek Lake supports a diverse fish community similar to other mature impoundments in Ohio. The number and percentage species composition of the fish collected is presented in Table 15.

By number, sunfishes (primarily bluegill), carp, and white crappie were the most abundant species collected during the first two years (1968-1969) following impoundment. All three species were indigenous to Deer Creek.

Spotted bass, which was the most abundant black bass species found in Deer

Table 15. -- Deer Creek Reservoir. Number and percentage composition (exclusive of gizzard shad) of fish collected from 1968 through 1980. One 1.8 m (6 ft) and one 4.3 m (14 ft) fyke nets were utilized for sampling between 1968-1977 (number of net hours in parenthesis). Electrofishing was accomplished with a 250-275 volt AC boat mounted generator (number of hours in parenthesis)

	Fyke net collection (1968-77)						Total fyke net		Electrofishing	
	1968-69 (384 hrs)		1970-74 (840 hrs)		1975-77 (432 hrs)		1,656 hrs)		1978-80 (9½ hrs)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Saugeye	-	-	-	-	-	-	-	-	388	7.3
Smallmouth bass	3	0.2	1	tr	-	-	4	0.1	45	0.8
Spotted bass	88	4.4	2	0.1	-	-	90	1.6	1	tr
Largemouth bass	30	1.5	8	0.4	19	1.2	57	1.0	934	17.5
Walleye	25	1.3	8	0.4	-	tr	34	0.6	2	tr
Muskellunge	-	-	4	0.2	-	-	4	0.1	4	0.1
White bass	-	-	7	0.3	127	8.2	134	2.3	17	0.3
Channel catfish	5	0.2	10	0.4	5	0.3	20	0.3	22	0.4
Subtotal	151	7.6	40	1.8	151	9.7	343	5.9	1,413	26.5
White crappie	263	13.1	888	39.7	46	3.0	1,197	20.7	390	7.3
Sunfish <sup>1/</sup>	927	46.3	678	30.3	981	63.1	2,586	44.7	1,662	31.2
Bullhead <sup>2/</sup>	29	1.5	45	2.0	17	1.1	91	1.6	4	0.1
Carp	518	25.9	350	15.8	232	14.9	1,100	19.0	1,116	20.9
Subtotal	1,737	87.0	1,961	87.8	1,276	82.1	4,974	86.0	3,172	59.5
Total (sport fish)	1,888	94.5	2,001	89.6	1,427	91.8	5,317	91.9	4,585	86.1
Suckers <sup>3/</sup>	94	4.7	218	9.8	116	7.5	427	7.4	727	13.6
Longnose gar	15	0.8	15	0.7	12	0.8	41	0.7	16	0.3
Subtotal (non-sport)	109	5.5	233	10.4	128	8.2	468	8.1	743	13.9
Cumulative total	1,997	100	2,234	100	1,555	100	5,785	100	5,328	100
Gizzard shad <sup>4/</sup>	19	(1)	1,125	(33)	3,034	(66)	4,178	(42)	7,079	(57)
Others <sup>5/</sup>	1		57		3		61		165	
Grand total	2,017		3,416		4,592		10,024		12,407	

<sup>1/</sup> Primarily bluegill with smaller numbers of longear sunfish, green sunfish, orange spotted sunfish, pumpkinseed sunfish, hybrid sunfish and rock bass.

<sup>2/</sup> Includes black, yellow and brown bullheads.

<sup>3/</sup> Primarily golden redhorse, quillback and bigmouth buffalo with smaller numbers of Ohio river redhorse, silver redhorse, spotted sucker, white sucker, and hog sucker.

<sup>4/</sup> Represents the percentage composition of the total number of fish collected.

<sup>5/</sup> Includes goldfish, minnows, darters, lampreys, grass pickerel, log perch and other darters.

Creek prior to impoundment, was the most frequently collected black bass during the first two years. Although not stocked, spotted bass were almost three times more abundant in the fyke net collections than largemouth bass, which had been stocked extensively in both 1968 and 1969. Among the other species stocked in 1968 and 1969 by the ODNR (walleye, muskellunge, striped bass, and channel catfish), only a small number of walleye and channel catfish appeared in the fyke net collections obtained during those years. Striped bass were never found in subsequent years. Muskellunge were taken occasionally, particularly in the tailwater in later years.

Various species of suckers (golden redhorse, quillback, spotted sucker, and bigmouth buffalo) were also collected. Gizzard shad, which became increasingly abundant in subsequent years, made up only 1 percent of the total number of fish collected in the 1968-1969 period.

During the next five years (1970-1974), the most notable change in relative species abundance was the substantial decline noted for large predator sport fish species. Species included in this group (the black basses, white bass, walleye, muskellunge, and channel catfish) registered a collective decline, from 7.6 percent of the total number of fish collected (exclusive of gizzard shad) during the 1968-1969 period to only 1.8 percent of the fishes collected over the next five years. This decline in relative abundance of predator sport fish species was accompanied by a commensurate increase in the relative abundance of suckers (primarily redhorse and quillback).

The ODNR attributed the substantial reduction in the relative abundance of

predator fishes in Deer Creek Lake to the excessive loss of fish from the lake which occurred during winter drawdown periods (17), viz:

A 23 to 25 foot drawdown from November 15, 1968 to April 9, 1969 resulted in massive losses of various fish species to the tailwater area. Losses of game fish during drawdown periods have severely hampered the establishment of game fish populations in the reservoir proper....Tailwater seining surveys indicated a high loss of game fish from the reservoir during winter drawdown. In addition, test net surveys indicated little or no success in establishing the above species in the reservoir through stocking efforts. Extensive studies by district personnel supported the belief that nearly all stocked game species were lost to the tailwaters during drawdown periods.

As a consequence, all stocking in Deer Creek Lake was terminated by order of the ODNR Director of Wildlife on May 3, 1971 (18). After a three-year hiatus (1971-1974), annual stocking of selected species was resumed in 1975 following modification of water release patterns by the CE during the winter of 1974 (19), viz:

The Corps of Engineers initiated a modified water release method during the 1974 drawdown because of recommendations from the District One Fish Management Section. The modification was an attempt to reduce fish losses from the lake to the tailwaters. In the spring of 1975, the moratorium of fish stocking at Deer Creek Lake was removed. Stockings of walleye, channel catfish and muskellunge were made to establish predator population in the fishery.

The modification adopted by the CE in the fall of 1974 essentially consisted of reducing the velocity of the discharge from the lake during the fall drawdown by utilizing all five bottom sluices, instead of one sluice as practiced in prior years (3), viz:

In order to minimize fish losses to the tailwaters, the District has instituted a five gate equalized bottom discharge during the scheduled fall drawdowns. This method of discharge will be continued in the future.

Although the relative abundance of the predator sport fish complex within the lake increased substantially in the subsequent three-year period (1975 through

1977), the increase appeared to be attributable primarily to an increase registered in the number of white bass collected rather than to increased abundance of stocked species.

Gizzard shad also increased substantially, from 33 percent of the total number of fish netted in the 1970-1974 period to 68 percent during the 1975-1977 period.

The increase in the relative abundance of the predator sport fish segment of the fish community noted during the 1975-1977 period accelerated over the next three years (1978 through 1980). Much of this increase could be attributed to the large population of "saugeye" (sauger x walleye hybrid) which developed in Deer Creek Lake as a result of a significant stocking effort (75,123 fingerlings plus 555 advanced fingerlings) initiated by the ODNR in 1978 (20). Additional saugeye were stocked in 1979 (244,671 fingerlings) and 1980 (43,170 fingerlings).

The relative abundance of largemouth bass and smallmouth bass also increased substantially during the 1978-1980 lake sampling period, although neither species had been stocked during the sampling period.

Electrofishing samples were obtained from the tailwater in the fall and winter of 1978-1979 and spring of 1979 (Table 16). These samples indicated that desirable sport fish species, particularly white crappie, white bass, walleye, and saugeye, exited Deer Creek Lake via the discharge sluices during the winter. It appeared evident that the major portion of the exodus from the lake



Table 16. -- Deer Creek Lake. Number, by species, of fish collected by electrofishing in the immediate lake tail-water prior to and during the fall drawdown of the lake level and after winter and spring flooding events

Lake discharge regime	Fall drawdown		Flood discharge	
	Prior	During	Winter	Spring
Prior discharge rate [m <sup>3</sup> /sec (cfs)]	7.4 (260)	7.4 (260)	70.8 (2,500)	3/30/79 <sup>3/</sup>
Date fish sampled	11/6/78	11/29/78 <sup>1/</sup>	12/18/78 <sup>2/</sup>	
No. fish collected				
Species				
Saugrey	0	11	31	177
Walleye	1	3	16	8
Largemouth bass	11	48	29	14
White crappie	0	8	663	2
White bass	0	0	218	3
Bluegill	29	21	79	33
Channel catfish	0	0	32	1
Redhorse sucker	337	259	62	205
Quillback	231	26	22	34
Gizzard shad	40	7	1	0
Carp	36	19	131	277
Spotted sucker	25	54	13	2

<sup>1/</sup>The fish collection was obtained approximately midway during the fall drawdown period in which the lake level was reduced approximately 4.3 m (14 ft) over a 30 day period.

<sup>2/</sup>The fish collection was obtained approximately three days after a period of rapid flood water release in which the lake level was reduced 3.7 m (12 ft) in only three days.

<sup>3/</sup>The fish collection was obtained in late spring following several late winter flood releases.

occurred concomitantly with periods of high floodwater discharge rates from the reservoir rather than during the scheduled fall drawdown period (20), viz:

A three part tailwater survey was conducted prior to, during, and after the scheduled 14 foot winter drawdown to evaluate the benefits of modified water release procedures and to document incidence of saugeye in the tailwater.

The surveys were conducted utilizing AC electrofishing equipment, with each survey consisting of one run along each bank and two runs through the middle of the tailwater pool. Due to extremely variable water temperatures, 54°F to 34°F, running speed varied greatly; thus, comparisons in incidence of catch will be based on total numbers observed as area covered during each survey was consistent. It is further noted that as the drawdown was reaching completion, floodwaters were held and the lake returned to near normal levels. The 14 foot drawdown, as scheduled, required nearly 30 days at an average discharge of 260 cfs. The flood water release, beginning December 12, in which the lake level was reduced 12 feet in three (3) days (2,500 cfs release), occurred prior to the post-drawdown survey and it is generally believed that this floodwater release resulted in much more severe losses of fish to the tailwater than scheduled releases....

Nearly all desirable species were taken in significantly greater number as the drawdown progressed. High water levels prior to and during the December 18 survey are believed to have resulted in the loss of many additional game fish to Deer Creek downstream from the sampled tailwater pool and decreased sampling efficiency on that date. All but six (6) of the white crappie and all of the white bass were from the 1978 year class while the channel catfish were yearling or adult fish. Although it was originally thought that a lack of suitable crappie spawning habitat was the primary cause of the extremely low in-lake crappie population, 1978 survey data along with drawdown survey observations indicate that loss of crappies to the tailwaters is a much more significant problem.

Although uncontrollable conditions such as weather, rate of flow and water temperature certainly affected catch rates, it is obvious that losses of desirable fish species to the tailwater are significant during floodwater releases....

An additional tailwater electrofishing survey was conducted on March 30, 1979, to determine tailwater fish populations following several late winter floodwater releases. The survey was conducted identically to the three fall-early winter surveys...

With the exception of saugeye, redhorse suckers, carp and quillback, the catch of major species (largemouth bass, bluegill, walleye, white crappie, and white bass) all dropped significantly. It is highly probable, based on past history, that

losses of these species continued to be severe and that the majority of individuals of these species had passed downstream below the sampled tailwater pool.

#### Angler use

Angler surveys of varying intensity have been conducted periodically by the ODNR at Deer Creek Lake and the tailwater. The most intensive creel survey information was collected from April 10 through August 25, 1979 (21). The CE also has made monthly estimates of angler man-day use on project waters annually.

During the April 10-August 25, 1979 creel survey, the ODNR estimated a total project angling pressure of some 134,207 hours, including 58,554 hours in the lake and 75,653 hours in the tailwater. Based on the average trip length of 4.3 hours documented for the Deer Creek Lake fishery and 3.0 hours in the tailwater, total angling man-day use was estimated by the ODNR at some 39,168 angling man-days, including 13,617 man-days for the lake and 25,551 man-days for the tailwater (Table 17).

Angling man-day use estimates made by the CE over this same time frame, 153,756 man-days, were more than 3.9 times greater than the ODNR estimate. The CE estimate for the lake fishery, 90,002 man-days, was 6.6 times larger, and the CE estimate for the tailwater fishery, 64,754 man-days, was 2.5 times greater than estimated during the ODNR creel survey. In addition, the CE estimated that project waters supported a total of 69,320 man-days (53,367 in the lake and 15,953 in the tailwater) during the period from August 26, 1979 through April 9, 1980.

Table 17. -- Deer Creek Lake. Estimated fishing man-day use for 12-month period extending from April 10, 1979, through April 9, 1980

	Period			
	4/10/79-8/25/79	8/26/79-4/9/80	12-month total	
	No. man-days	No. man-days	No. man-days	No./ha
<u>Lake [517 ha (1,277 ac)]</u>				
CE estimate	90,002	53,367	143,369	277
ODNR creel survey	13,617			112
Ratio	6.610			
Adjusted estimate	13,617	8,075*	21,692	42
Adjusted estimate				17
<u>Fallwater [0.6 ha (1.4 ac)]</u>				
CE estimate	63,754	15,953	79,707	140,681
ODNR creel survey	25,551			56,934
Ratio	2.495			
Adjusted estimate	25,551	6,394*	31,945	56,382
Adjusted estimate				22,818
<u>Total project [518 ha (1,278.4 ac)]</u>				
CE estimate	153,756	69,320	223,076	432
ODNR creel survey	39,168			179
Adjusted estimate	39,168	14,469*	53,637	104
Adjusted estimate				42

\*Assumes same CE/ODNR creel survey man-day use ratio as prevailed during the ODNR creel survey period.

Thus, assuming the same ODNR/CE man-day use ratios calculated for the ODNR creel survey period prevailed for the remainder of the year, the total annual angling man-day use at the Deer Creek Lake project from April 10, 1979 through April 9, 1980 amounted to some 53,637 man-days. This adjusted estimate of man-day use amounts to an overall project angling pressure of 104 man-days/ha/year (42/ac) on the 517 ha (1,277 ac) lake and the small 0.6 ha (1.4 ac) tailwater. Angling pressure on Deer Creek Lake amounted to 42 man-days/ha (17/ac) and 56,382 man-days/ha (22,818/ac) on the tailwater.

Based on the 1979 ODNR/CE man-day use ratios, the adjusted CE angling man-day use estimates have averaged 87,298 man-days per year over the past five years (1977-1981). The highest estimate (127,855 man-days) was registered in 1981 and the lowest (53,508 man-days) in 1979 (Table 18).

It is noteworthy that anglers evidently considered carp to be an acceptable sport fish species. Carp ranked as the most frequently harvested fish from project waters, constituting almost one of every four fish harvested. The relative abundance of carp in the creel was similar to its abundance in fish samples collected during fish community studies.

The number and relative species abundance (percentage composition) of the fish harvested from Deer Creek Lake and the tailwater is presented in Table 19. It should be emphasized that these data represent only a partial estimate of the total annual fish harvest, as the creel survey period (April 10 through August 25) did not reflect the substantial fall recreational fishery which is known to occur in the fall and winter months.

Table 18. -- Deer Creek Lake. Comparison of annual fishing man-day use in lake and tailwater estimated by CE with adjusted estimates derived from the 1979 ODNR creel survey

	1977		1978		1979		1980		1981		Average (1977-81)	
	CE	Adjust.	CE	Adjust.	CE	Adjust.	CE	Adjust.	CE	Adjust.	CE	Adjust.
No. man-days												
Lake	102,000	15,431	165,300	25,008	142,800	21,604	158,300	23,949	228,100	34,508	159,300	24,100
Tailwater	95,200	38,156	136,300	54,629	79,600	31,904	244,400	97,956	232,900	93,347	157,680	63,198
Total no.	197,200	53,587	301,600	79,637	222,400	53,508	402,700	121,905	461,000	127,855	316,980	87,298
% tailwater	48	71	45	69	36	59	61	80	51	73	50	72
No./ha												
Lake	197	30	320	48	276	42	306	46	441	67	308	47
Tailwater	168,026	67,344	240,566	96,419	140,536	56,310	431,360	172,890	411,063	164,755	278,301	111,543
Total	382	104	584	154	430	103	778	238	892	247	613	169
No./ac												
Lake	80	12	129	20	112	17	124	19	179	27	125	19
Tailwater	68,000	27,254	97,357	39,021	56,875	22,789	174,571	69,969	166,357	66,676	112,679	45,141
Total	154	42	236	62	174	42	315	95	361	100	248	69

\*Adjusted man-day use estimates based on CE/ODNR man-day use estimate ratios prevailing during the 1979 ODNR creel survey (6.610 for lake fishery and 2.495 for tailwater fishery).

Table 19. -- Deer Creek Lake. ODNH creel survey summary, April 10 through August 25, 1979

Species	Lake		No. fish harvested Tailwater		Total		No. fish harvested/hr. *		No. fish harvested/ha (no./ac.)	
	No.	%	No.	%	No.	%	Lake	Tailwater	Lake	Total
Carp	2,294	13.4	10,142	30.6	12,436	24.8	0.039	0.164	4.4	(1.8) 24.1 (9.7)
Saugeye	834	4.9	10,466	31.6	11,300	22.5	0.014	0.138	1.6	(0.65) 21.9 (8.8)
White crappie	4,356	25.5	4,781	14.4	9,137	18.2	0.074	0.063	8.4	(3.4) 17.7 (7.2)
Bluegill	4,092	24.0	2,109	6.4	6,201	12.4	0.070	0.028	7.9	(3.2) 12.0 (4.9)
Channel catfish	2,261	13.2	2,204	6.7	4,465	8.9	0.039	0.029	4.4	(1.8) 8.6 (3.5)
White bass	1,297	7.6	219	0.7	1,516	3.0	0.022	0.003	2.5	(1.0) 2.9 (1.2)
Largemouth bass	963	5.6	335	1.0	1,298	2.6	0.016	0.004	1.9	(0.8) 2.5 (1.0)
Walleye	68	0.4	253	0.8	321	0.6	0.001	0.004	0.1	(0.05) .6 (0.3)
Other	903	5.3	2,627	7.9	3,530	7.0	0.015	0.047	1.7	(0.7) 6.8 (2.8)
Total	17,068		33,136		50,204		0.291	0.438	33.0	(13.4) 97 (39)

\*A total of 134,207 hours fished, including 58,554 hours on the lake and 75,653 hours in the tailwater.

The species harvested in greatest relative abundance from Deer Creek Lake, as estimated by the ODNR creel survey, were white crappie (25.5 percent of the number of fish harvested), bluegill (24.0 percent), carp (13.4 percent), and channel catfish (13.2 percent). Among the major sport fish predator species, the white bass was most frequently harvested (7.6 percent of the total number of fish harvested), followed by largemouth bass (5.6 percent). The percentage composition of the creel made up by largemouth bass undoubtedly would have been higher if the creel survey period had extended through the fall months. As attested by bass fishing tournament records of the Ohio Chapter of the Bass Anglers Sportsman Society, angler effort and catch rate per unit effort are particularly high for largemouth bass at Deer Creek Lake during September and October (22).

Saugeye, comprising 31.6 percent of the total number of fish harvested, and carp (30.6 percent) dominated the tailwater recreational fishery, followed by white crappie (14.4 percent) and channel catfish (6.7 percent). Largemouth bass comprised only 1 percent of the total number of fish harvested in the tailwater and white bass only 0.7 percent. ODNR creel survey estimates for saugeye harvest should be considered minimal, as the data do not reflect the substantial harvest of saugeye known to have occurred from the tailwater during the winter months (23).

Walleye, which had been stocked extensively by the ODNR in previous years, made up only 0.4 percent of the lake harvest and 0.8 percent of the fish harvested from the tailwater. In contrast, another heavily stocked fish, saugeye, made a major contribution to the creel in comprising a total of 22.5 percent of the total angler harvest, including both the lake and tailwater.



#### Fishery Resources--Evaluation of Planning Input

The FWS prepared and submitted five separate planning reports to the CE pertinent to the Deer Creek Lake project. The initial November, 1948 FWS report appraisal of project-associated fishery resources appeared to adequately satisfy the limited scope of project objectives as outlined by the CE. At the time the FWS report was submitted, the Deer Creek Lake project was conceived by the CE as a "dry dam project" which would provide only temporary flood control storage without any provision for a permanent pool.

No record of further fishery planning by the FWS for the Deer Creek Lake project was found until submission of the preliminary FWS reconnaissance report on July 12, 1961 dealing with CE proposals for construction of eight flood control projects within the Scioto River Basin. CE planning at this juncture provided for a permanent minimum pool of 308 ha (760 ac) at the Deer Creek Lake project.

Two subsequent reports were submitted by the FWS later in 1961 (November 16). These FWS reports, which consisted of a brief letter-report and a more comprehensive substantiating report, provided a thorough evaluation of the anticipated impacts of the proposed project on the fishery resource and recreational fishery within the Deer Creek project impact area. The only interim change noted in the project design was a slight reduction in the size of the proposed permanent minimum pool, from 308 ha (760 ac), as listed in the July 12, 1961 FWS report, to 271 ha (670 ac) in the November 16, 1961 FWS reports.

The last FWS report which dealt with the fishery resources associated with the Deer Creek Lake project was submitted to the CE on May 14, 1964. This FWS

special letter-report dealt exclusively with planning for reservoir discharge facilities and the tailwater recreational fishery.

For the most part, the FWS reports submitted in 1961 and 1964 contained appropriate recommendations designed to protect and enhance the fishery resources associated with construction of the Deer Creek Lake project. The May 14, 1964 FWS report, in particular, correctly anticipated and made appropriate recommendations to mitigate the substantial fish loss from the lake via the discharge sluices which subsequently occurred in post-impoundment years (15), viz:

Water depth at the dam at minimum pool will be about 20 feet and at full flood pool about 60 feet. The water quality may vary at different levels. In order to provide for flexibility in the elevation from which reservoir water may be released downstream a low flow by-pass or by-passes capable of passing at least 200 cfs should be located with invert elevation at 786' or 10' below the elevation of the top of the minimum pool.

The release of flood waters from bottom sluice gates results in substantial fish loss at some reservoirs. Fish are swept by high velocity currents through the sluice gates into the tailwaters. The sudden decrease in external pressure causes damage to vital organs. This fish loss can be moderated by the manner in which the gates are operated. Opening several gates a small amount will result in a reduction of fish loss through the sluices as compared with opening one gate an amount sufficient to handle the entire downstream release. The manner in which flood water is released should be coordinated with the Ohio Division of Wildlife....

Although the lake discharge design features recommended by the FWS were implemented by the CE, the FWS recommendation pertaining to the operation of the discharge sluices was not implemented until 1974, some six years after impoundment. Apparently neither the CE nor the ODNR was aware of the prior 1964 FWS report recommendation, as modification of the lake discharge regime by the CE in 1974 occurred only after a direct request from the ODNR.

In most instances, project planning for the Deer Creek Lake project reflected

excellent coordination between the CE, FWS, and the ODNR. However, there was a major discrepancy regarding the ultimate size of the Deer Creek Lake pool as finally constructed [517 ha (1,277 ac)] and as described in prior FWS planning documents, which apparently reflected inadequate coordination between the CE and FWS during the final phases of project planning.

Project design information made available to the FWS by the CE prior to the submission of the 1961 and 1964 FWS planning reports indicated that the primary project-associated fishery habitat would include only a permanent minimum pool plus those sections of Deer Creek located within the flood pool and tailwater. Thus, all of the fishery resource recommendations and use predictions contained in the FWS reports were based on the assumption that the project would not include a seasonal recreation pool, as was finally provided. However, the CE apparently was actively considering inclusion of a seasonal pool for the project as early as October of 1964.

A review memorandum, dated October 27, 1964, from the Ohio River Division, CE, to the Huntington District Engineer pointed out the necessity of providing for a summer seasonal pool in the Deer Creek Lake project to justify recreational benefits claimed (24), viz:

Investigate the physical feasibility of adding a seasonal pool above the permanent pool to provide a more favorable relationship between pool and developable lands and to substantially increase the acreage of usable lands and length of shoreline. This seasonal pool should be maintained from May 1 through September 15....

Review of the general design memorandum shows that aside from the size of the pool there are almost no other project features to support the attendance (benefits) claimed for recreation. It is firmly believed that these recreation benefits cannot be defended as this report goes forward.

In a December 15, 1964 response to the Ohio River Division, CE, the Huntington District Engineer expressed the opinion that geological conditions in the area of the Deer Creek project indicated that leakage from the dam might prevent establishment of a seasonal summer pool (25), viz:

All revisions requested in the review memorandum enclosed with ORDED-T 1st Ind dated 27 October 1964 have been accomplished except the establishment of a seasonal pool. The feasibility of establishing a seasonal pool was studied for this report. However, geologic investigations made to study reservoir leakage indicate that leakage from the reservoir above elevation 796 may be such that during periods of low summer inflow, it may not be possible to maintain a pool above the minimum pool elevations. Therefore, the plans in this memorandum are based on a reservoir without a seasonal pool and all recreation benefits are based on the minimum pool at elevation 796. However, all recreational development has been planned so that a seasonal pool can be established at elevation 810 without adverse effects. Therefore, since the only added costs involved in establishing a seasonal pool would be for the additional clearing, it is proposed that, over a period of several years following completion of construction, an attempt be made to maintain a seasonal pool and definitely establish the feasibility of permanently providing such a pool as a part of the reservoir regulation. If the seasonal pool can be maintained, the additional recreation benefits would more than offset the costs for the additional clearing.

Provision for a summer recreational pool to be established at elevation 247 m (810 ft) msl at the Deer Creek Lake project was subsequently endorsed by the ODNR in a February 16, 1965 letter addressed to the Huntington District, CE, office in Huntington, West Virginia (26), viz:

Pool level. It is recommended that the final summer pool elevation be permanently established at the highest elevation approaching 810, which the Corps finds feasible in view of the possible leakage problem at the dam site.

This uncertainty with regard to the pool level and acreage covered has a definite bearing on the planning of the area. It is felt that the plan should be flexible enough to adjust land uses to the possible raises in pool levels.

The inability of the FWS to anticipate the larger ultimate size of Deer Creek Lake in their planning reports could have been expected to have resulted in an

underestimation of post-impoundment recreational fishing participation. In fact, however, FWS report predictions of post-impoundment angling man-day use, although based on expectations of a much smaller lake, proved to be substantially overstated (Table 20).

Estimates of post-impoundment creel surveys conducted by the ODNR in 1979 indicated an annual angling effort of only 21,692 man-days in the 517 ha (1,277 ac) lake. This level of fishing pressure, amounting to 42 fishing man-days/ha (17/ac), was less than one-eighth of the level of fishing pressure as predicted in the 1961 FWS reports [331 man-days/ha (134/ac)].

Conversely, the 1961 FWS planning report prediction of post-project angling man-day use in the tailwater [5,175 man-days spread over some 12.5 km (7.75 mi)] was several-fold less than the estimate derived from the 1979 creel survey conducted by the ODNR [a total of 31,945 man-days from an abbreviated 0.6 ha (1.4 ac) area located immediately below the dam].

Thus, including both the lake and tailwater, the Deer Creek Lake project impact area supported an estimated total of 53,637 fishing man-days. This level of fishing pressure, although approximately 70 percent less than post-impoundment predictions contained in the FWS planning reports, was some eleven times greater than the 4,800 fishing man-days anticipated within the project impact area without the project in place.

Possible reasons for the woefully inaccurate FWS report predictions of post-impoundment angling man-day use were not readily apparent. Regrettably, the

Table 20. -- Deer Creek Lake. Comparison of angling man-day use predictions contained in the November 16, 1961 FWS report and post-impoundment occurrences as estimated from a creel survey conducted by the ODNR in 1979

	With-the-project predictions	Post-impoundment occurrences	Net	
			No.	% change
Deer Creek Lake				
Area [ha (ac)]	271 (670)	517 (1,277)	+246 (607)	+91
Fishing man-days				
Number	89,800	21,692	-68,108	-38
No/ha (no/ac)	331 (134)	42 (17)	-289 (92)	-87
Tailwater				
Length [km (mi)]	12.5 (7.75)	0.4 (0.25)*	-12.25 (7.5)	-97
Fishing man-days				
Number	5,175	31,945	+26,770	+464
Total project area				
Fishing man-days				
Number	94,975	53,637	-41,338	-44
No/ha (no/ac)	350 (141)*	104 (42)*	-246 (99)	-70

\*Assumes tailwater extends downstream from dam to first riffle (approximately 0.4 km (0.25 mi) containing 0.6 ha (1.4 ac) as defined in post-impoundment creel survey conducted by the ODNR.

FWS reports did not contain any descriptive information concerning the rationale and/or methodology employed for generating post-impoundment fishing man-day use predictions.

Such information should be routinely included in all planning reports, as the accuracy of man-day use predictions is directly dependent upon the efficacy of the predictive methodology utilized.

## SUMMARY

Deer Creek Lake is located on Deer Creek, a tributary of the Scioto River, in Pickaway, Madison, and Fayette Counties, Ohio, approximately 56 km (35 mi) south of metropolitan Columbus and 11 km (7 mi) southeast of Mount Sterling, Ohio.

The project was constructed as a unit of the comprehensive flood control plan for the Ohio River basin and authorized under authority of the Flood Control Act of June, 1938, for the control of floods on Deer Creek and the Scioto River. Secondary purposes include fish and wildlife enhancement and general recreation.

The fertile 717 km<sup>2</sup> (277 mi<sup>2</sup>) Deer Creek drainage basin is almost entirely agricultural, with corn ranking as the most important crop, followed by soybeans, hay, and cereals. Wooded areas within the basin consist of scattered upland woodlots of small size and a narrow fringe of bottomland hardwoods along the watercourses.

The growing season averages approximately 160 days, extending from about May 1 through October 10.

The Deer Creek Lake project purchase area totals approximately 2,923 ha (7,223 ac) and includes 2,406 ha (5,946 ac) of land circumscribing the 517 ha (1,277 ac) Deer Creek Lake at summer seasonal pool elevation 246.9 m (810 ft) msl.

Some 700 ha (1,731 ac) of project land above summer seasonal pool elevation is



maintained by the Ohio Department of Natural Resources (ODNR) as a state park (Deer Creek State Park) and 1,565 ha (3,867 ac) for wildlife management purposes (Deer Creek Wildlife Area). Some 141 ha (348 ac) has been retained by the U.S. Army Corps of Engineers (CE) for administrative purposes.

At the top of design flood pool elevation, 257.3 m (844 ft) msl, the lake would encompass 1,637 ha (4,046 ac). The surface area of the lake is reduced to 294 ha (727 ac) during the winter at minimum pool elevation 242.6 m (765 ft) msl. The average depth of the lake at summer seasonal pool elevation is 5.0 m (16.5 ft), with a maximum depth of 12.2 m (40 ft). The outlet works consist of one 1 m (3.0 ft) diameter low flow sluice located approximately 7.3 m (25 ft) below the lake surface at summer seasonal pool, and a series of five sluices [1.5 m (5 ft) x 1.7 m (5.5 ft), each] located at invert elevation 235.5 m (772 ft) msl.

Six separate reports concerning the Deer Creek Lake project were prepared by the FWS over a 16-year period extending from November, 1948 through November, 1964. Each of these FWS reports was prepared in response to changes in project objectives and associated engineering design which occurred over the years.

The initial (November, 1948) FWS report evaluated impacts on fish and wildlife resources anticipated from construction of a single-purpose project designed by the CE solely for temporary flood storage. Only marginal damage to wildlife resources was predicted to occur within the project impact area, as the temporary 1,085 (2,680 ac) flood pool was expected to be dewatered as quickly as possible after each flooding occasion. The FWS evaluation of project impacts on

wildlife resources contained in the report was superficial, consisting primarily of an unsupported statement that without-the-project wildlife resource values assessed at \$400 annually would be reduced to \$300 with the project in place. No attempt was made to document pre-construction or post-project wildlife density levels and/or related hunting man-day use anticipated within the project area.

A pre-project value of \$9,000 was assessed for the stream fishery within the project impact area, including \$3,000 for the 16 km (10 mi) stream within the proposed maximum flood pool and \$6,000 for the 32 km (20 mi) tailwater. Project construction was expected to result in a loss of \$600 annually in stream values above the dam, which would be offset by a commensurate increase of \$600 in the tailwater.

No record of further fish and wildlife planning by the FWS for the Deer Creek Lake project was found until submission of the preliminary FWS reconnaissance report on July 12, 1961, dealing with CE proposals for construction of eight flood control projects within the Scioto River Basin, including Deer Creek Lake. CE planning at this juncture provided for a permanent minimum pool of 308 ha (760 ac) at the Deer Creek Lake project. This FWS report contained several excellent recommendations for assuring the preservation and development of wildlife resources on lands to be incidentally acquired by the CE within the 5-year flood pool [809 ha (2,000 ac)]. Such lands were to be signed and fenced at project expense and licensed to the ODNR for intensive game management.

Two subsequent reports were submitted by the FWS on November 16, 1961. The FWS reports, which consisted of a brief letter-report and a more detailed

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EVALUATION OF PLANNING FOR FISH & WILDLIFE DEER CREEK  
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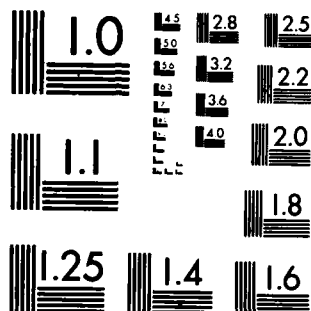
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substantiating report, provided a thorough evaluation of the anticipated -  
pacts of the proposed project on fish and wildlife resources within the Deer  
Creek project impact area, including specific estimates of fishing and hunting  
man-day use.

The November 16, 1961 FWS report predicted that the project would support an  
average of 115,375 fishing man-days per year valued at \$173,063 over the desig-  
nated 50-year life of the project. This predicted level of fishing pressure  
amounted to a 24-fold increase over the average annual number of without-the-  
project fishing man-days (4,800) and monetary value (\$7,200) afforded by the 26  
km (16 mi) section of Deer Creek within the project impact area.

The total predicted post-project recreational fishery included some 89,800  
fishing man-days per year [331 man-days/ha (134/ac)] valued at \$134,700 which  
was expected to develop in the 271 ha (670 ac) minimum pool of Deer Creek Lake.  
Construction of the proposed 24 ha (60 ac) waterfowl sub-impoundment was ex-  
pected to provide 5,400 angling man-days per year valued at \$8,100.

An additional 20,175 stream fishing man-days per year, valued at \$30,263, were  
expected to occur in sections of Deer Creek located within the project impact  
area, including 15,000 man-days valued at \$22,500 within the 8 km (5 mi)  
stretch of Deer Creek located immediately upstream from the proposed lake and  
5,175 man-days in the tailwater. Without the project, the stream fishery above  
the lake was expected to provide only 185 man-days and the tailwater fishery  
only 2,400 man-days.

Without mitigation, a loss of 292 hunting man-days at the Deer Creek Lake project was predicted as a result of project construction, including 210 man-days for farm game, 32 man-days for raccoon and fox hunting, and 50 man-days for waterfowl. Assuming full implementation of FWS wildlife resource mitigation recommendations, which included the purchase of an additional 344 ha (850 ac) of land, construction of a 24 ha (60 ac) waterfowl sub-impoundment, and annual pheasant stocking, the project was expected to fully compensate for the loss of the 210 man-days of upland game hunting at the Deer Creek project and provide a bonus of 5,660 hunting man-days for upland game valued at \$14,150 and 9,288 hunting man-days for waterfowl valued at \$31,950. The total initial investment cost necessary to provide the additional hunting benefits was estimated by the FWS at \$220,540. The net average annual value of the predicted increase in fishing man-day use within the project impact area attributed to project construction alone (\$165,826) was several times greater than the estimated total annualized cost of implementing the entire fish and wildlife plan recommended by the FWS (\$51,420).

The FWS submitted several additional planning reports in 1964. The final FWS report dealing with fishery resources was submitted May 14, 1964 and dealt exclusively with planning for reservoir discharge facilities and the recreational fishery in the tailwater. The FWS planning reports dated June 8, 1964 and November 6, 1964 provided an update of FWS wildlife resource recommendations included in the July 13, 1961 report based on receipt of new land acquisition policies which had been adopted by the CE in the interim.

Collectively, the FWS reports submitted to the CE in 1961 and 1964 appeared to

adequately address the fish and wildlife resources problems posed by each of the various development regimes advanced by the CE over time. FWS recommendations for mitigation and/or enhancement of fish and wildlife resources were well conceived.

In addition to the previously recommended purchase of a 344 ha (850 ac) tract as mitigation for wildlife losses expected at the Deer Creek project, the November 16, 1961 FWS report recommended the purchase of an additional 243 ha (600 ac) tract for partial mitigation of upland game losses anticipated from development of two other proposed reservoir sites (Mill Creek and Alum Creek Reservoirs).

For various reasons, these well-conceived November, 1961 FWS recommendations calling for land purchase and wildlife resource development beyond the authorized land acquisition zone were never implemented.

For example, the November, 1961 FWS report recommendation for the acquisition of the 243 ha (600 ac) tract at Deer Creek Lake project for mitigation of upland game resource losses anticipated from construction of the Alum Creek and Mill Creek reservoir projects became moot, as neither project was included in the final CE development plan finally approved for the Scioto River Basin.

The need for additional project lands for mitigation of upland game resources was reduced considerably by interim changes in land acquisition policies which resulted in the purchase of substantially more land [1,619 ha (4,000 ac)] than originally proposed [1,137 ha (2,810 ac)].

Also, although initially approved by the CE, efforts to amend project authorization to include the acquisition and development of the recommended waterfowl management area were unsuccessful--primarily because of opposition by the United States Bureau of the Budget. After due consideration, the FWS decided not to request development of the previously recommended waterfowl management area.

Most of the fishery-resource-related recommendations were later implemented by the CE. The May 14, 1964 FWS report correctly anticipated and made appropriate recommendations to mitigate the substantial fish loss from the lake via the discharge sluices which subsequently occurred in post-impoundment years. The report recommended installation of a low flow by-pass facility located at invert elevation 240 m (786 ft) msl, or 3 m (10 ft) below the top of the minimum pool to supplement the five discharge sluices located near the bottom of the lake. Also, this FWS report suggested that the discharge of flood waters from the project be accommodated by opening all of the discharge gates a small amount rather than opening one gate sufficiently wide to accommodate the entire downstream release.

Although the lake discharge design features recommended by the FWS were implemented by the CE, the FWS recommendation pertaining to the operation of the discharge sluices was not implemented until 1974, some six years after impoundment. Apparently, neither the CE nor the ODNR was aware of the prior 1964 FWS report recommendation, as modification of the lake discharge regime by the CE in 1974 occurred only after a direct request from the ODNR.

In most instances, project planning for the Deer Creek Lake project reflected



excellent coordination between the CE, FWS, and the ODNR. However, there was a major discrepancy regarding the ultimate size of the Deer Creek Lake pool as finally constructed [517 ha (1,277 ac)] and as described in prior FWS planning documents, which apparently reflected inadequate coordination between the CE and FWS during the final phases of project planning.

Project design information made available to the FWS by the CE indicated that the project would include only a permanent minimum pool of some 308 ha (760 ac). Thus, all of the fish and wildlife resource recommendations and use predictions contained in the FWS reports were based on the assumption that the project would not include the much larger seasonal recreation pool [517 ha (1,277 ac)], as was finally provided. However, the CE was actively considering inclusion of a seasonal pool for the project as early as October of 1964. A review memorandum dated October 17, 1964, from the Ohio River Division, CE, to the Huntington District Engineer, pointed out the necessity of providing for a summer seasonal pool in the Deer Creek Lake project to justify recreational benefits claimed.

Post-impoundment assessments of fishing and hunting man-day use were considerably below the levels predicted by the FWS. Documented post-impoundment hunting man-day use, 10,218 man-days, was 61 percent lower than predicted. Hunting effort for upland game species (pheasants, rabbits, and squirrels) was estimated at 8,311 man-days during the 1980-1981 OCWRU survey, or some 66 percent lower than the 24,280 man-days predicted in the final November 6, 1964 FWS report. Hunting effort for waterfowl, estimated at only 345 man-days during the 1980-1981 OCWRU survey, was 83 percent lower than the 2,000 man-days predicted by the FWS.

On the other hand, the FWS failed to foresee the substantial increase in the white-tailed deer population which occurred in post-project years. Deer were rarely found within the general vicinity of the project in pre-project years. However, contrary to FWS predictions that the project impact area would not afford any post-project hunting opportunity for deer, the OCWRU survey report estimated a total of 1,562 hunting man-days were spent exclusively in pursuit of deer during the 1980-1981 hunting season.

The considerably larger ultimate size of Deer Creek Lake as finally constructed [517 ha (1,277 ac), as compared to the 308 ha (760 ac) size originally contemplated by the FWS] could have been expected to have resulted in an underestimation of post-impoundment predictions made by the FWS. In fact, however, FWS report predictions of post-impoundment angling man-day use proved to be substantially overstated.

Estimates derived from post-impoundment creel surveys conducted by the ODNR in 1979 indicated an annual angling effort of only 21,692 man-days in the 517 ha (1,277 ac) lake. This level of fishing pressure, amounting to 42 fishing man-days/ha (17/ac) was less than one-eighth of the level of fishing pressure as predicted in the 1961 FWS reports [331 man-days/ha (134/ac)].

Conversely, the 1961 FWS planning report prediction of post-project angling man-day use in the tailwater [5,175 man-days spread over some 12.5 km (7.75 mi)] was several-fold less than the estimate derived from the 1979 creel survey conducted by the ODNR [a total of 31,945 man-days from an abbreviated 0.6 ha (1.4 ac) area located immediately below the dam].

Thus, including both the lake and tailwater, the Deer Creek Lake project impact area supported an estimated total of 53,637 fishing man-days, or approximately 70 percent less than the post-impoundment prediction contained in the FWS planning report.

However, estimated total post-impoundment hunting man-day use constituted a twelve-fold increase over the level predicted by the FWS without the project. Fishing man-day use within the project impact area was eleven times greater than anticipated without the project in place.

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